Application Note

VG024 Band Matching Reference Designs

The Communications Edge ™

Product Information

The WJ VG024 variable gain amplifier can operate over a very broad range of frequencies (50 - 2200MHz), but needs specific matching circuits for specific bands of interest. At the maximum gain state, reasonable matching is only available for about ±10% of the reference frequency. The amplifier operates with a typical current of 150 mA at +5 V while the attenuator current can be varied from 0 to 30 mA, while maintaining constant OIP3 and P1dB. The RF matching of the VG024 for the entire frequency range can be accomplished with the systematic adjustment of only a few parts. The RF matching is not influenced by different attenuator drive methods provided there is adequate decoupling of the attenuator bias. This reference application circuit uses voltage applied between +Vatten and –Vatten. Rlim is a current limiting resistor to help linearize the drive of the attenuator and give better attenuator current control. *Single ended drive can be implemented by grounding –Vatten and placing an inductor the same value as the RF chokes at Rlim.* Different circuits for driving the variable attenuator are covered in a separate application note.

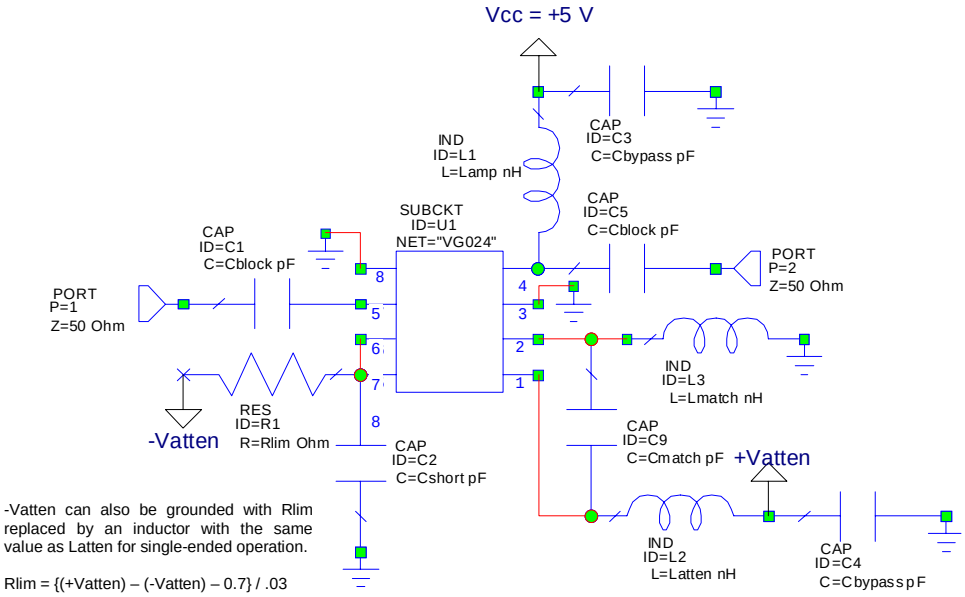
Pick the frequency of interest. Choose blocking capacitor values which give RF impedance of less than 3 ohms. Choose the RF chokes for the largest inductance while still having resonant frequency about 30% greater than the Reference frequency (this allows for good isolation and inductor variation). Next choose Lmatch and Cmatch for interstage matching. Cmatch is only needed for lower frequencies and determines the low frequency roll off of the gain. Lmatch will have dominant control over the input and output return losses at maximum gain state (0 mA gain control pin current). Cshort is needed to resonate the package parasitics to achieve the maximum attenuation values with attenuator current. With attenuator control pin current of 30 mA, Cshort can be chosen to provide maximum attenuation. See the chart below for suggested component values and predicted performance at various reference frequencies. Component values can be interpolated for reference frequencies not listed.

For lower frequencies the lumped element values can be used and the layout with unplaced component pads does not greatly affect the RF performance of the circuit. For frequencies greater than 500 MHz, component size and trace length have more influence on circuit performance. Smaller components and shorter trace lengths reduce the affects of the external component parasitics and interaction with the multichip module parasitics.

Matching Values and Typical RF Performance

Reference Frequency	MHz	70	170	240	400	850	1100	1850	2100
Frequency Band	MHz	60-80	155-185	220-260	360-440	770-930	1000-1200	1700-2000	2000-2200
$C_{block/bypass}$, C1, C5	pF	1000	470	330	150	68	47	33	33
C_{short}, C2	pF	10000	10000	10000	1000	22	12	3.6	3
C_{bypass}, C3, C4	µF	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C_{match}, C9	pF	22	7.5	2.7	DNP	DNP	DNP	DNP	DNP
L_{match}, L3	nH	270	68	47	22	5.6	2.7	DNP	DNP
L_{atten}, L1	nH	220	220	220	100	22	18	15	10
L_{amp}, L2	nH	220	220	220	100	33	27	18	18
Attenuation Range (30mA)	dB	18	18	18	18	19	17	10	10
S21 – Gain	dB	16	16	16	16	15	13	9.5	9
S11 – Input Return Loss	dB	-10	-10	-10	-10	-6	-10	-15	-10
S22 – Output Return Loss	dB	-12	-11	-11	-10	-7	-7	-15	-15
Output IP3 (+10 dBm / tone, 2 MHz spacing)	dBm	40	41	41	41	40.5	40	40	40
Noise Figure (at min. attenuation, Vatten=0V)	dB	6.5	6	5.5	5	5	5.5	6	6.5

DNP=Do Not Place



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