

Technical Note – TN1E

1 dB Compression Point

This is the output power level where a 10 dB increase at the input produces a 9 dB increase in output power. ($10\text{ dB} - 9\text{ dB} = 1\text{ dB}$) Below this point the amplifier is said to be operating in the „linear region”. In FIGURE 1 it can be seen that as input power increases from -18 dBm to about -10 dBm, there is a 1 to 1 ratio with the output power. For a 1 dB change in input, there is 1 dB change in output power. This is the linear operating region.

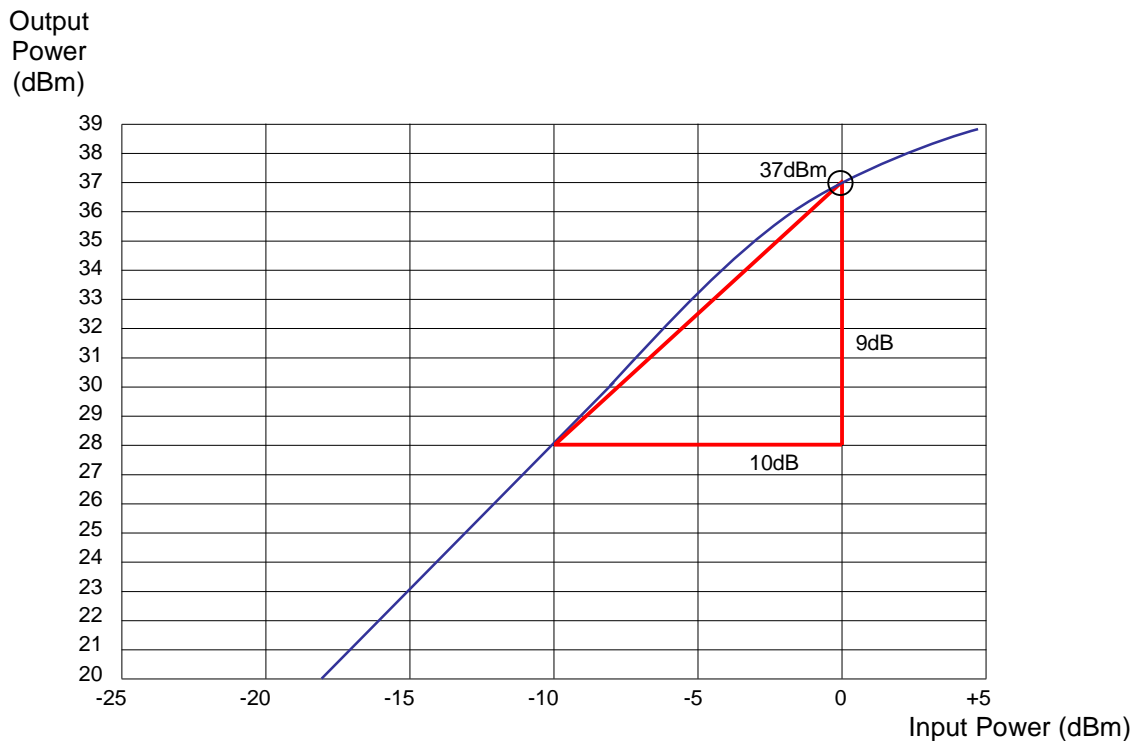


FIGURE 1

Gain

Typically operating power gain (G_p) relationship is considered.

$$G_p = \frac{P_L}{P_{in}} = \frac{\text{Power_delivered_to_the_load}}{\text{Power_input_to_the_network}}$$

Gain Flatness / Gain Ripple

Gain flatness over a specified bandwidth is usually defined as the total +/- peak amplitude variation across the frequency band of interest. Gain flatness includes the fine band, known as gain ripple, and the overall shape of the gain, or gain slope. Typically, gain flatness becomes worse as the amount of gain is increased due to the additional stages required for higher gain. The gain ripple usually gets higher in magnitude as gain stages are increased due to the VSWR interactions of the individual cascaded gain stages. (See FIGURE 2)

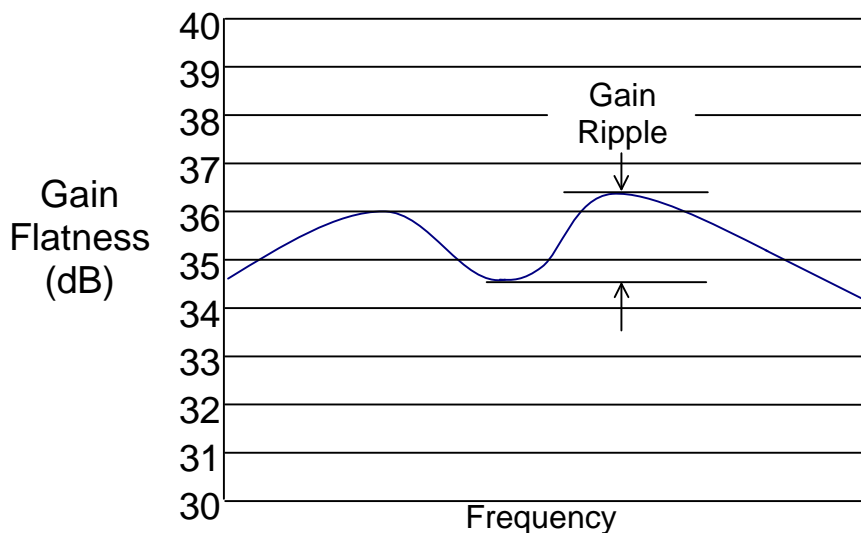


FIGURE 2

Harmonic Distortion

Amplifier non-linearities can manifest themselves as discrete output signals at integer multiples of the fundamental frequency. These harmonics cause distortion in the received signal and/or interference with other channels. The second harmonic output for small signal amplifiers is typically on the order of 20 to 25 dBc (dB below the carrier) when measured at the amplifier 1 dB compression point.

VSWR/Return Loss

The Voltage Standing Wave Ratio or VSWR is the ratio of the maximum voltage to the minimum voltage along a transmission line. It is used to denote the degree of match (or mismatch) of a load relative to the system's characteristic impedance.

Return loss is the ratio of the incident power to the reflected power at a point on a transmission line and is expressed in decibels(dB). Return loss is also used to define the degree of match of a load to the system's characteristic impedance.

The relationship between VSWR and Return Loss are as follows:

$$VSWR = r = \frac{|E|_{\max}}{|E|_{\min}} = \frac{|I|_{\max}}{|I|_{\min}} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

Gamma = Reflection Coefficient = reflected voltage (E_r) wave with respect to the incident voltage (E_i) wave.

$$\text{Reflection Coefficient} = \Gamma = \frac{E_r}{E_i}$$

$$\text{Return Loss} = -20 \log |\Gamma|$$

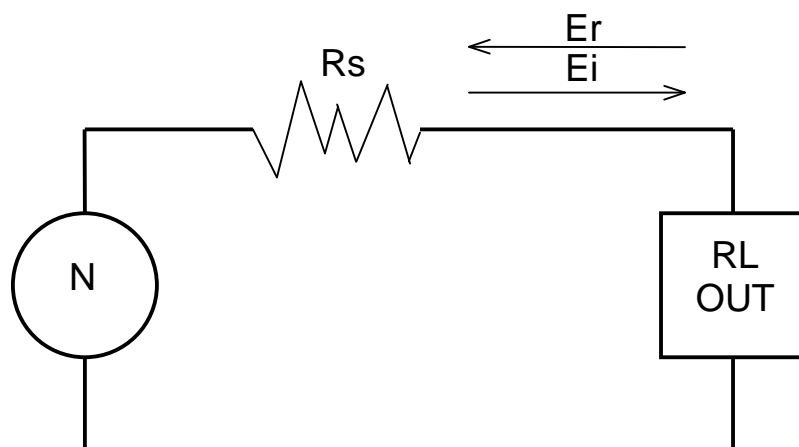


FIGURE 3

Conversion Charts

EFFECT OF VSWR ON TRANSMITTED POWER					
VSWR	RETURN LOSS (dB)	TRANS. LOSS (dB)	VOLT. REFL. COEFF.	POWER REFL. (%)	POWER TRANS. (%)
1.00	00	0.000	0.00	0.0	100.0
1.01	46.1	0.000	0.00	0.0	100.0
1.02	40.1	0.000	0.01	0.0	100.0
1.03	36.6	0.001	0.01	0.0	100.0
1.04	34.2	0.002	0.02	0.0	100.0
1.05	32.3	0.003	0.02	0.1	99.9
1.06	30.7	0.004	0.03	0.1	99.9
1.07	29.4	0.005	0.03	0.1	99.9
1.08	28.3	0.006	0.04	0.1	99.9
1.09	29.3	0.008	0.04	0.2	99.8
1.10	26.4	0.010	0.05	0.2	99.8
1.11	25.7	0.012	0.05	0.3	99.7
1.12	24.9	0.014	0.06	0.3	99.7
1.13	24.3	0.016	0.06	0.4	99.6
1.14	23.7	0.019	0.07	0.4	99.6
1.15	23.1	0.021	0.07	0.5	99.5
1.16	22.6	0.024	0.07	0.5	99.5
1.17	22.1	0.027	0.08	0.6	99.4
1.18	21.7	0.030	0.08	0.7	99.3
1.19	21.2	0.033	0.09	0.8	99.2
1.20	20.8	0.036	0.09	0.8	99.2
1.25	19.1	0.054	0.11	1.2	98.8
1.30	17.7	0.075	0.13	1.7	98.3
1.40	15.6	0.122	0.17	2.8	97.2
1.50	14.0	0.177	0.20	4.0	96.0
1.60	12.7	0.238	0.23	5.3	94.7
1.70	11.7	0.302	0.26	6.7	93.3
1.80	10.9	0.370	0.29	8.2	91.8
1.90	10.2	0.440	0.31	9.6	90.4
2.00	9.5	0.512	0.33	11.1	88.9
3.00	6.0	1.24	0.50	25.0	75.0
4.00	4.4	1.93	0.60	36.0	64.0
5.00	3.5	2.55	0.67	44.4	55.6
10.0	1.7	4.80	0.82	66.9	33.1
20.0	0.9	7.41	0.90	81.9	18.1

POWER-CONVERSION CHART		
dBm (mW)	dBm (mW)	dBm (mW)
-20 = 0.010	-7 = 0.200	+6 = 3.98
-19 = 0.012	-6 = 0.250	+7 = 5.01
-18 = 0.016	-5 = 0.316	+8 = 6.30
-17 = 0.020	-4 = 0.398	+9 = 7.94
-16 = 0.025	-3 = 0.501	+10 = 10.0
-15 = 0.032	-2 = 0.630	+11 = 12.6
-14 = 0.040	-1 = 0.794	+12 = 15.8
-13 = 0.050	0 = 1.00	+13 = 19.9
-12 = 0.063	+1 = 1.25	+14 = 25.1
-11 = 0.079	+2 = 1.58	+15 = 31.6
-10 = 0.100	+3 = 2.00	+16 = 39.8
-9 = 0.130	+4 = 2.51	+17 = 50.1
-8 = 0.160	+5 = 3.16	+18 = 63.1
		+19 = 79.4
dBm (W)	dBm (W)	dBm (W)
+20 = 0.100	+34 = 2.55	+48 = 63.1
+21 = 0.120	+35 = 3.16	+49 = 79.4
+22 = 0.159	+36 = 3.91	+50 = 100.0
+23 = 0.200	+37 = 5.01	+51 = 126.0
+24 = 0.251	+38 = 6.31	+52 = 158.0
+25 = 0.316	+39 = 7.94	+53 = 200.0
+26 = 0.398	+40 = 10.0	+54 = 251.0
+27 = 0.501	+41 = 12.6	+55 = 316.0
+28 = 0.631	+42 = 15.8	+56 = 398.0
+29 = 0.794	+43 = 20.0	+57 = 501.0
+30 = 1.00	+44 = 25.1	+58 = 631.0
+31 = 1.26	+45 = 31.6	+59 = 794.0
+32 = 1.59	+46 = 39.8	+60 = 1KW
+33 = 2.00	+47 = 50.1	