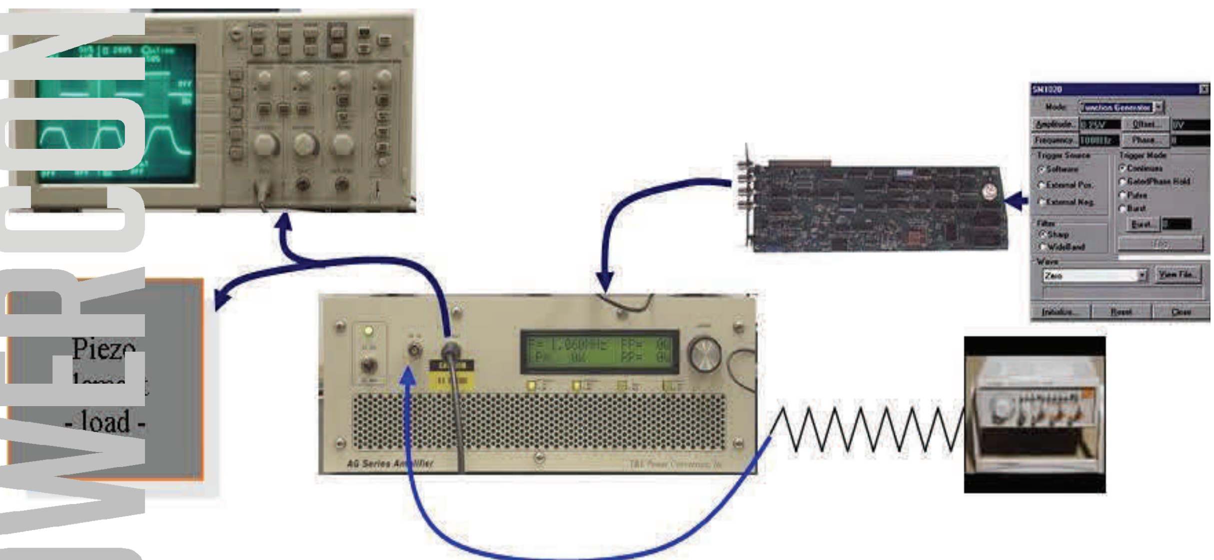
AMPLIFIER APPLICATION HANDBOOK

T&CPOWERCONVERSIONINC



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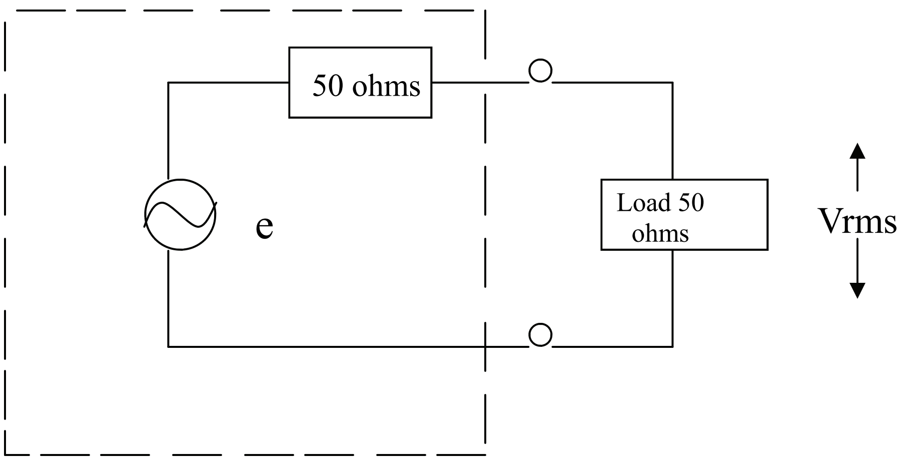
Operation into 50 Ohm Load



For an amplifier, the voltage across a 50 ohms load is given by:

$V_{rms} = \sqrt{(P)(50)}$ where P is the rated power

In high impedance loads, the output voltage of an amplifier will typically be twice the voltage present on a 50 ohms load.

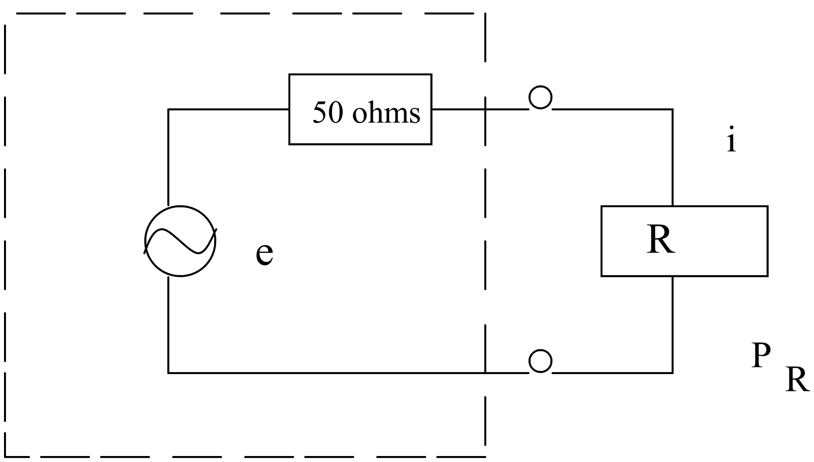
$E = 2\sqrt{(P)(50)}$

The power, voltage or current related to a load other than 50 ohms can therefore be easily calculated.

$$i = \frac{2\sqrt{(P)(50)}}{(R+50)}$$

$$P_R = \frac{(200)(P)(R)}{(R+50)^2}$$

$$V = \left[\frac{2\sqrt{(P)(50)}}{R+50)}\right] [R]$$



Power into a 25 ohm load with a T&C amplifier rated at 100 Watts into a 50 ohm is therefore:

$$P_{25} = \frac{(200)(100)(25)}{(75)^2} = 88.88 \text{ Watts}$$

STEP UP TRANSFORMERS

The basic relationship is: $(\Delta V_{rms} \rightarrow (\Delta)^2$ load impedance

For example, a 100W amplifier into a 50 ohm load produces: $V_{rms} = \sqrt{(100W)(50 \text{ ohms})} = 70.7$ Vrms

If customer needs 2 X 70.7 Vrms or 141.4 Vrms, load impedance change becomes: $(2)^2 \times 50$ ohms = 200 ohms

NOTES:

1. If a customer states that he wants higher voltage but the load impedance must remain 50 ohms, the solution is a higher power amplifier, not a transformer. For example, if he needs 141.4 Vrms,

$$P = \frac{(V_{rms})^2}{R} \qquad P = \frac{(141.4)^2}{50} \qquad P = 400 \text{ Watts}$$

2. If the customer miscalculates the load impedance, he will see the following results from the transformer:
   a. If load impedance is higher than calculated, higher voltage will be seen, i.e. $(V_{rms})^2$=Power x Load R
   b. If load impedance is lower than calculated, lower voltage will result and the higher current may become an issue.

REFLECTED POWER WITH VSWR

Reflected power = p^2 (Po)

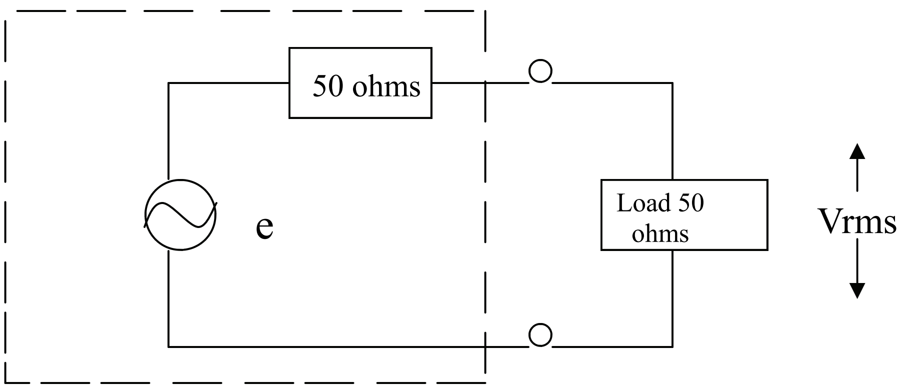
where p = reflected coefficient

Po = Output power

$$P = \frac{VSWR - 1}{VSWR + 1}$$

VSWR	P	Reflected Power
1.5	0.20	4%
2	0.33	11%
3	0.50	25%
4	0.60	30%

Operation into load other than 50 ohms.



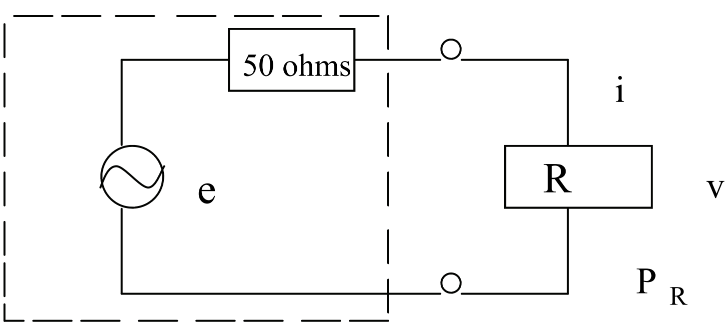
For an amplifier the voltage across a 50 ohm load is given by

$V_{rms} = \sqrt{P \times 50}$ where P is the rated power

Since the source impedance is well defined the open circuit voltage

$e = 2\sqrt{P \times 50}$

The Power, voltage or current related to a load other than 50ohms can therefore be easily calculated.



$$i = \frac{2\sqrt{P*50}}{(R+50)}$$

$$V = \frac{2\sqrt{P*50}}{(R+50)}\ R$$

$P_R = \underline{200\ P*R.}\quad 2$

Power into a 25 ohm load with an amplifier rated at 100 Watts into 50 ohms is:

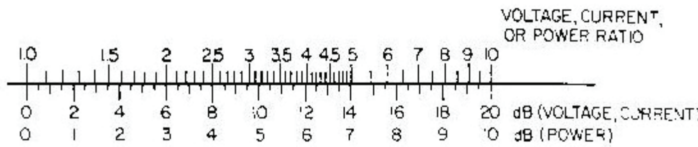
$$P_{25} = \frac{200 \times 100 \times 25}{(75)^2} = 88.88 \text{ Watts.}$$

Conversion of Voltage and Power Ratios to dB

The equation:

$$\mathrm{dB} = 20 \log \frac{E_1}{E_2} = 10 \log \frac{P_1}{P_2}$$

is frequently used to determine the effects of component and system inter-connections. This nomograph presents the equation in graph form.



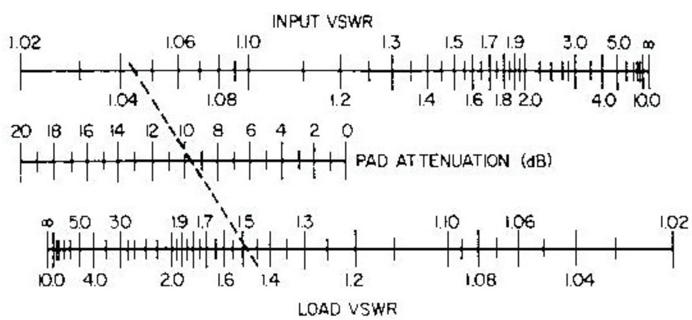
Effect of Attenuating Pads on VSWR

In an electrically "long" transmission line that is not terminated in its characteristic impedance, the VSWR, S, is defined as:

$$S = \frac{E_{\max}}{E_{\min}} = \frac{1 + \rho}{1 - \rho}$$

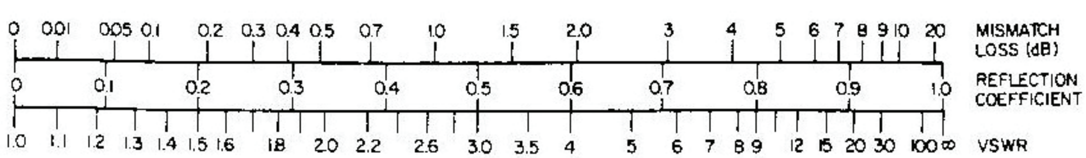
Where E is the voltage measured along the line, and p is the termination voltage reflection coefficient. Insertion of an attenuator having the same characteristic impedance as that of the line will diminish both the incident wave to the load and the reflected wave returning to the input source, causing the VSWR at the input side to be diminished, as expressed by the equation:

$$\frac{1}{S_1} = \tanh \left[\alpha + \tanh^{-1} \frac{1}{S_2}\right]$$



Where subscripts 1 and 2 refer to the input and load sides of the pad, respectively, and α is the pad attenuation in nepers. Determination of the attenuation required to reduce the VSWR to a desired value is facilitated by means of this nomograph.

Effect of Impedance Mismatch on VSWR and Transmitted Power Loss



It is often necessary to determine the power mismatch loss that results when the load impedance is not matched to the line, which can be expressed as:

$$\text{mismatch loss (dB)} = 10 \log \frac{P_m}{P}$$

$$= 10 \log \frac{1}{1 - \rho^2} = 10 \log \frac{(S + 1)^2}{4S}$$

Where P= power delivered to the load and Pm = power that would be delivered if the impedances were matched for maximum power transfer. These relationships are shown graphically in this nomograph.

RF Power Amplifiers

1. POWER OUTPUT AND DISTORTION

One of the most misunderstood and abused specifications of an linear amplifier is the specified power output.

The power output capability of an amplifier has absolutely no meaning unless accompanied by the distortion level and the output load impedance specification.

There are two types of distortion which concern the user. These are Total Harmonic Distortion and Intermodulation Distortion.

TOTAL HARMONIC DISTORTION

Linearity

The linearity of an amplifier is expressed in terms of output power into a specific load impedance for a given amount of harmonic distortion. The total harmonic distortion THD is defined as:

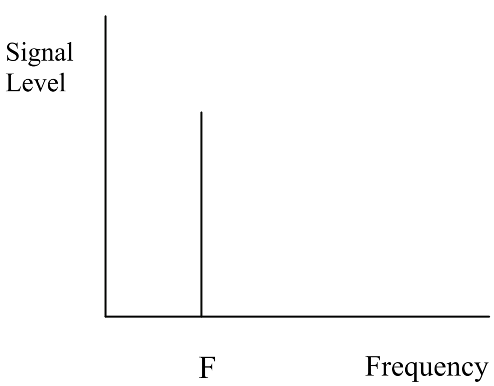
$$\%THD = \sqrt{E_2^2 + E_3^2 + E_4^2 + E_n^2} \times 100\%$$

Where $E_2 = \frac{\text{E 2nd harmonic}}{\text{E fundamental}}$

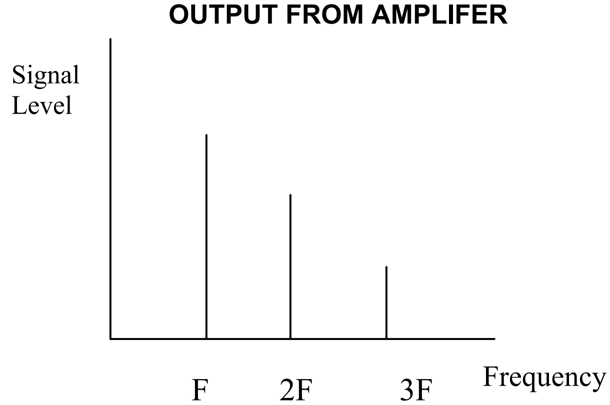
$E_n = \frac{\text{E nth harmonic}}{\text{E fundamental}}$

Harmonic distortion can be illustrated by the two spectrum displays shown:

INPUT TO AMPLIFIER



OUTPUT FROM AMPLIFER



Distortion level is strictly dependent on power output. A reduction of 3 dB in output power will reduce the distortion by 3 dB. The maximum allowable output power for a required distortion level can therefore be calculated from the amplifier specification or tabulation.

INTERMODULATION DISTORTION
Non-Linearity

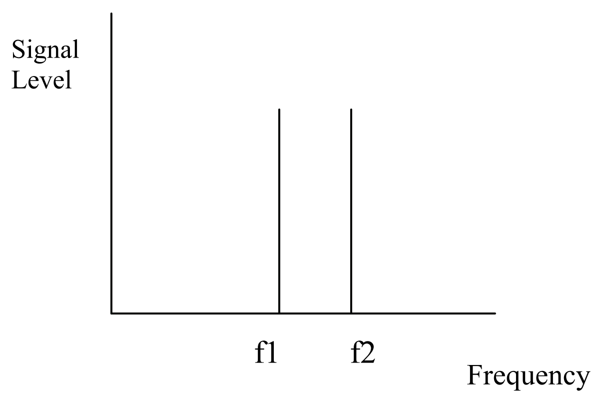
The intermodulation performance of an amplifier is a measure of its non-linearity.

One way to measure intermodulation distortion is to inject two signals of equal amplitude whose frequencies are separated by a small amount (for example use one signal at **f1 = 100 MHz** and one at **f2 = 105 MHz**).

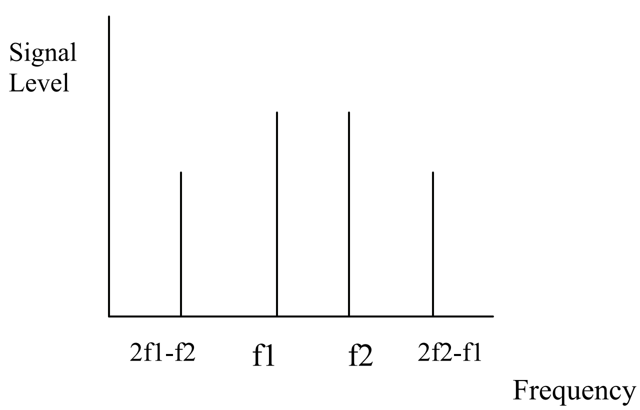
Intermodulation gives rise to 2nd, 3rd, 4th, 5th, etc. intermodulation products.

The spectrum displays below illustrate 3rd order intermodulation products.

INPUT TO AMPLIFIER

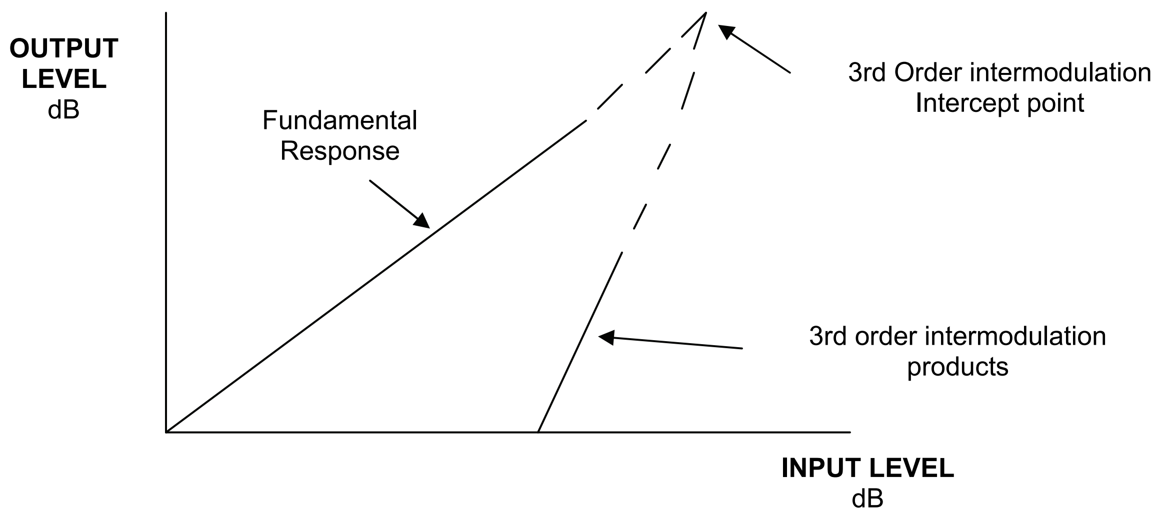


AMPLIFIER OUTPUT



Often a specification will quote “how many db’s down the intermodulation products are with reference to the two test signal’s,” or “Below—x dB with respect to the wanted signal” for example.

A more useful way of determining an amplifiers intermodulation performance utilizes the intercept point plot. This is shown below.

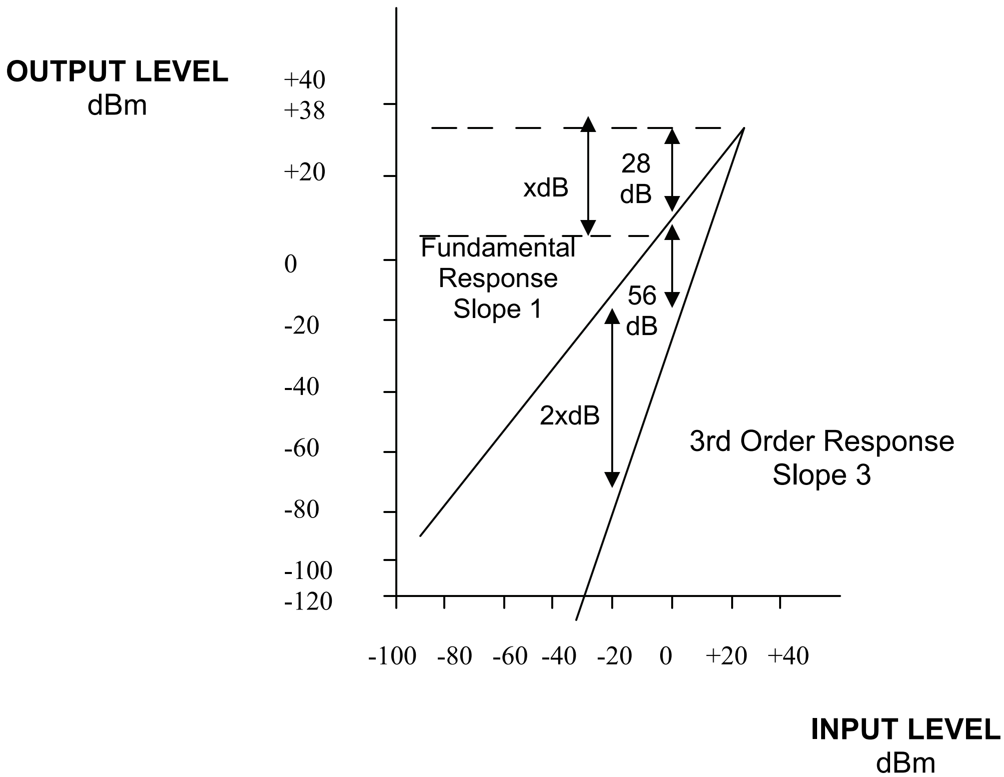


The “fundamental” response line indicates the output level of either of the two signals applied to the input. The third intermodulation product line indicates the level of the third order intermodulation products. Both lines have been extrapolated to meet at a point which is known as the “Third Order Intermodulation Intercept Point.”

Both theory and test results show that the fundamental and intermodulation responses are exponentially related. When plotted on a log-log scale as shown each response will be a straight line. The slope of the line is a function of the “order” of the intermodulation product. For example, the 3rd order response has a slope 3 times that of the fundamental response.

A third order product consists of two “parts: of one frequency plus one “part” of the other frequency. For example: - Third order products of 2 signals of frequencies f1 and f2 are 2f1-f2 and 2f2-f1.

The graph below shows an intercept point plot measured using an amplifier model LA 25, two (2) signal generators (one at 50 MHz, the other at 55 MHz) and a HP 8590A spectrum analyzer.



It is not necessary to plot a graph each time, since as long as the intercept point is known the intermodulation values can be calculated, since the 3rd order response will always have a slope 3 time that of the fundamental.

Example 1

What is the level of the 3rd order products with +10 dBm output using model LA 50? (Third order intermodulation intercept point is at +38 dBm)

+10dBm is 28 dB less than the +38 dBm intercept point.
The intermodulation products will be 2 x 28 dB (56dB) less +10 dBm, i.e. at –46 dBm.

Example 2
What is the level of the 3rd order intermodulation products with –20 dBm output using model LA50?
-20 dBm is 58 dBm less than the +38 dB intercept point.
Therefore the 3rd order products are 2 x 58 dB = 116 less than the output signal.
The 3rd order products are therefore at –136 dBm.

Thus the 3rd order intermodulation products may be calculated for any output if the 3rd order intermodulation intercept point is known. T&C states the Third Order I.I.P. for each of its amplifiers. The tabulations on amplifier performance also show intermodulation performance with power output for –25 dB and –30 dB intermodulation.

As in the case of Total Harmonic Distortion an improvement a 6dB reduction in power output. It is therefore possible to estimate maximum allowable power output for a required level of intermodulation for any T&C amplifier using the tabulations.

2. NOISE

The excess noise contributed by an amplifier is referred to as its Noise Figure. The Noise Figure for the Model LA50 is 12 dB. This means that the equivalent noise at the input is 12 dB higher than that produced by thermal energy.

One may translate the Noise Figure into equivalent noise voltage in the following manner: volts or 22 microvolts into 50 ohms

P thermal + 12 dB = P equivalent noise

-92 dBm + 12dB = -80 dBm = P equivalent noise

P equivalent noise = 10^{-11} watts

E equivalent noise = $\sqrt{P.R}$ = 22×10^{-6} volts or 22 microvolts into 50 ohms

Since the equivalent input noise is –80 dBm and the signal required for a maximum output of 50 watts is –3 dBm, the dynamic range of the LA50 is 77 dB.

3. OUPUT LOAD IMPEDANCE AND OUPUT IMPEDANCE

There is a very important distinction to be made between the output load impedance and the output impedance of an amplifier.

The output load impedance refers to the optimum load impedance which when connected to the amplifier output will produce specified output power. It does not say a thing about the output impedance of the amplifier.

The T&C family of amplifiers has an output impedance of 50 Ohms (typical VSWR of 2) and will work into any output load impedance.

The amplifiers produce their rated power output at the output connectors, regardless of load impedance. Power reflected due to output load mismatch is absorbed in the amplifier.

For example: a 10 Watt amplifier available from another vendor will only supply 2.5 watts into a 25 Ohm load. The Model LA10 will supply 9 Watts into a 25ohm load and absorb the 1 Watt of reflected energy. The comparison is even more startling with even poorer load matches.

4. PULSE OPERATION

The broad bandwidth of T&C amplifiers make them ideally suited for many pulse applications. Since the amplifiers are transformer coupled, only RF triggered pulses can be applied. Application of video pulses is possible at some reduced output power level for LA series amplifiers.

The pulse operation of a Class 'A' amplifier is unlike that of a Class "B" or "C," which can produce relatively high pulse power compared to its average power. A T&C Class "A" amplifier can only produce about 1.5 times the linear power since the amplifier stages then reach saturation.

Rise and fall times depend on the particular model, but are typically 3-4 nanoseconds for the ULTRA and AG series and less than 1 nanosecond for the LA series. Overshoot is within 10%.

Phase shift between input and output of an amplifier can be calculated to a good approximation by using group delay figures as follows:

1) Phase shirt in degrees = delay x freq x 360

2) Group Delay = $\dfrac{\text{Phase shift}}{\text{Frequency x 360}}$

3) Frequency = $\dfrac{\text{Phase Shift}}{\text{Delay x 360}}$

Group delay for AG/ULTRA series is approximately 28 nanoseconds
Group delay for the LA series is approximately 10 nanoseconds

5. FAILSAFE

In general to consider an amplifier reasonably safe, it must pass three tests:

1) The amplifier output must operate with an open or short circuit connected at the load.
2. The amplifier must stand up to overdrive.
3) The amplifier must withstand both of the above occurring simultaneously.

The T&C family of amplifiers will take up to +5 dB of INPUT overdrive. It is not recommended to overdrive the INPUT beyond its nominal recommended level when operating into short or open circuit load indefinitely.

T&C products use modern LD-MOSFET devices offering broad range of operation, great output characteristics but in some operating conditions are more fragile then the older bipolar devices when operating into high VSWR loads. Please note this!

The AG and ULTRA series amplifiers are protected by its internal monitoring system up to an appropriate amount for that model's specified level of Watts of Forward and Reflected Power. This will protect the amplifier output stage from accidental extreme mismatch at the Output. The RF INPUT for these series are follow by INPUT Limiter, circuit that will automatically and instantaneously clip the signal entering an amplifier.

Most signal and sweep generators will supply a maximum output of 1 volt RMS. The T&C family of amplifiers cannot be damaged when driven by these units, under any conditions.

Decibels ↔ Volts ↔ Watts
Conversion Table
(50Ω Terminated System)

dBm	V	Po
+ 53	100.0	200 W
+ 50	70.7	100 W
+ 49	64.0	80 W
+ 48	58.0	64 W
+ 47	50.0	50 W
+ 46	44.5	40 W
+ 45	40.0	32 W
+ 44	32.5	25 W
+ 43	32.0	20 W
+ 42	28.0	16 W
+ 41	26.2	12.5 W
+ 40	22.5	10 W
+ 39	20.0	8 W
+ 38	18.0	6.4 W
+ 37	16.0	5 W
+ 36	14.1	4 W
+ 35	12.5	3.2 W
+ 34	11.5	2.5 W
+ 33	10.0	2 W
+ 32	9.0	1.6 W
+ 31	8.0	1.25 W

dBm	V	Po
+ 30	7.10	1.0 W
+ 29	6.40	800 mW
+ 28	5.80	640 mW
+ 27	5.00	500 mW
+ 26	4.45	400 mW
+ 25	4.00	320 mW
+ 24	3.55	250 mW
+ 23	3.20	200 mW
+ 22	2.80	160 mW
+ 21	2.52	125 mW
+ 20	2.25	100 mW
+ 19	2.00	80 mW
+ 18	1.80	64 mW
+ 17	1.60	50 mW
+ 16	1.41	40 mW
+ 15	1.25	32 mW
+ 14	1.15	25 mW
+ 13	1.00	20 mW
+ 12	0.90	16 mW
+ 11	0.80	12.5 mW
+ 10	0.71	10 mW

dBm	V	Po
+ 9	0.64	8 mW
+ 8	0.58	6.4 mW
+ 7	0.500	5 mW
+ 6	0.445	4 mW
+ 5	0.400	3.2 mW
+ 4	0.355	2.5 mW
+ 3	0.320	2.0 mW
+ 2	0.280	1.6 mW
+ 1	0.252	1.25 mW
0	0.225	1.0 mW
- 1	0.200	0.80 mW
- 2	0.180	0.64 mW
- 3	0.160	0.50 mW
- 4	0.141	0.40 mW
- 5	0.125	0.32 mW
- 6	0.115	0.25 mW
- 7	0.100	0.20 mW
- 8	0.090	0.16 mW
- 9	0.080	0.125 mW
- 10	0.071	0.10 mW

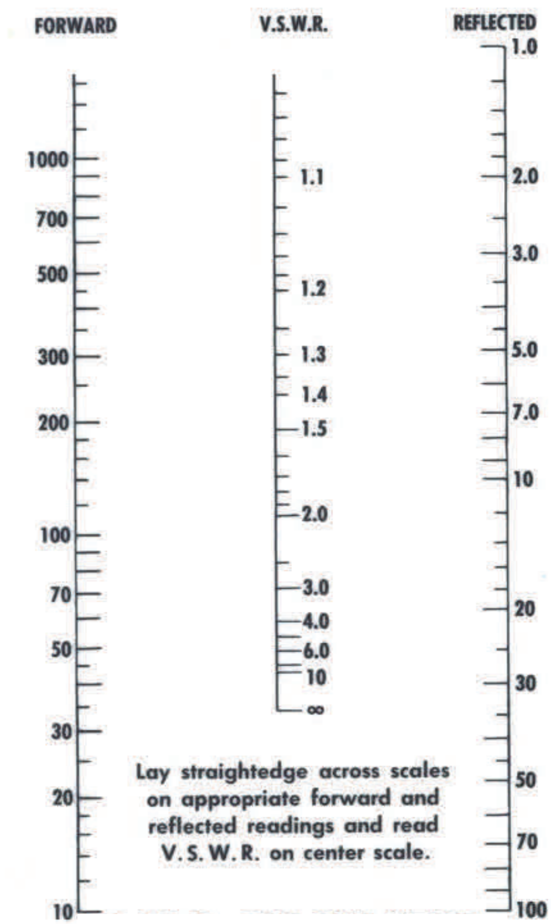
VSWR vs. Transmitted Power

VSWR	VSWR (dB)	RETURN LOSS (dB)	TRANS. LOSS (dB)	VOLT. REFL. COEFF.	POWER TRANS. (%)	POWER REFL. (%)	VSWR	VSWR (dB)	RETURN LOSS (dB)	TRANS. LOSS (dB)	VOLT. REFL. COEFF.	POWER TRANS. (%)	POWER REFL. (%)
1.00	.0	∞	.000	.00	100.0	.0	1.64	4.3	12.3	.263	.24	94.1	5.9
1.01	.1	46.1	.000	.00	100.0	.0	1.66	4.4	12.1	.276	.25	93.8	6.2
1.02	.2	40.1	.000	.01	100.0	.0	1.68	4.5	11.9	.289	.25	93.6	6.4
1.03	.3	36.6	.001	.01	100.0	.0	1.70	4.6	11.7	.302	.26	93.3	6.7
1.04	.3	34.2	.002	.02	100.0	.0	1.72	4.7	11.5	.315	.26	93.0	7.0
1.05	.4	32.3	.003	.02	99.9	.1	1.74	4.8	11.4	.329	.27	92.7	7.3
1.06	.5	30.7	.004	.03	99.9	.1	1.76	4.9	11.2	.342	.28	92.4	7.6
1.07	.6	29.4	.005	.03	99.9	.1	1.78	5.0	11.0	.356	.28	92.1	7.9
1.08	.7	28.3	.006	.04	99.9	.1	1.80	5.1	10.9	.370	.29	91.8	8.2
1.09	.7	27.3	.008	.04	99.8	.2	1.82	5.2	10.7	.384	.29	91.5	8.5
1.10	.8	26.4	.010	.05	99.8	.2	1.84	5.3	10.6	.398	.30	91.3	8.7
1.11	.9	25.7	.012	.05	99.7	.3	1.86	5.4	10.4	.412	.30	91.0	9.0
1.12	1.0	24.9	.014	.06	99.7	.3	1.88	5.5	10.3	.426	.31	90.7	9.3
1.13	1.1	24.3	.016	.06	99.6	.4	1.90	5.6	10.2	.440	.31	90.4	9.6
1.14	1.1	23.7	.019	.07	99.6	.4	1.92	5.7	10.0	.454	.32	90.1	9.9
1.15	1.2	23.1	.021	.07	99.5	.5	1.94	5.8	9.9	.468	.32	89.8	10.2
1.16	1.3	22.6	.024	.07	99.5	.5	1.96	5.8	9.8	.483	.32	89.5	10.5
1.17	1.4	22.1	.027	.08	99.4	.6	1.98	5.9	9.7	.497	.33	89.2	10.8
1.18	1.4	21.7	.030	.08	99.3	.7	2.00	6.0	9.5	.512	.33	88.9	11.1
1.19	1.5	21.2	.033	.09	99.2	.8	2.50	8.0	7.4	.881	.43	81.6	18.4
1.20	1.6	20.8	.036	.09	99.2	.8	3.00	9.5	6.0	1.249	.50	75.0	25.0
1.21	1.7	20.4	.039	.10	99.1	.9	3.50	10.9	5.1	1.603	.56	69.1	30.9
1.22	1.7	20.1	.043	.10	99.0	1.0	4.00	12.0	4.4	1.938	.60	64.0	36.0
1.23	1.8	19.7	.046	.10	98.9	1.1	4.50	13.1	3.9	2.255	.64	59.5	40.5
1.24	1.9	19.4	.050	.11	98.9	1.1	5.00	14.0	3.5	2.553	.67	55.6	44.4
1.25	1.9	19.1	.054	.11	98.8	1.2	5.50	14.8	3.2	2.834	.69	52.1	47.9
1.26	2.0	18.8	.058	.12	98.7	1.3	6.00	15.6	2.9	3.100	.71	49.0	51.0
1.27	2.1	18.5	.062	.12	98.6	1.4	6.50	16.3	2.7	3.351	.73	46.2	53.8
1.28	2.1	18.2	.066	.12	98.5	1.5	7.00	16.9	2.5	3.590	.75	43.7	56.2
1.29	2.2	17.9	.070	.13	98.4	1.6	7.50	17.5	2.3	3.817	.76	41.5	58.5
1.30	2.3	17.7	.075	.13	98.3	1.7	8.00	18.1	2.2	4.033	.78	39.5	60.5
1.32	2.4	17.2	.083	.14	98.1	1.9	8.50	18.6	2.1	4.240	.79	37.7	62.3
1.34	2.5	16.8	.093	.15	97.9	2.1	9.00	19.1	1.9	4.437	.80	36.0	64.0
1.36	2.7	16.3	.102	.15	97.7	2.3	9.50	19.6	1.8	4.626	.81	34.5	65.5
1.38	2.8	15.9	.112	.16	97.5	2.5	10.00	20.0	1.7	4.807	.82	33.1	66.9
1.40	2.9	15.6	.122	.17	97.2	2.8	11.00	20.8	1.6	5.149	.83	30.6	69.4
1.42	3.0	15.2	.133	.17	97.0	3.0	12.00	21.6	1.5	5.466	.85	28.4	71.6
1.44	3.2	14.9	.144	.18	96.7	3.3	13.00	22.3	1.3	5.762	.86	26.5	73.5
1.46	3.3	14.6	.155	.19	96.5	3.5	14.00	22.9	1.2	6.040	.87	24.9	75.1
1.48	3.4	14.3	.166	.19	96.3	3.7	15.00	23.5	1.2	6.301	.88	23.4	76.6
1.50	3.5	14.0	.177	.20	96.0	4.0	16.00	24.1	1.1	6.547	.88	22.1	77.9
1.52	3.6	13.7	.189	.21	95.7	4.3	17.00	24.6	1.0	6.780	.89	21.0	79.0
1.54	3.8	13.4	.201	.21	95.5	4.5	18.00	25.1	1.0	7.002	.89	19.9	80.1
1.56	3.9	13.2	.213	.22	95.2	4.8	19.00	25.6	.9	7.212	.90	19.0	81.0
1.58	4.0	13.0	.225	.22	94.9	5.1	20.00	26.0	.9	7.413	.90	18.1	81.9
1.60	4.1	12.7	.238	.23	94.7	5.3	25.00	28.0	.7	8.299	.92	14.8	85.2
1.62	4.2	12.5	.250	.24	94.4	5.6	30.00	29.5	.6	9.035	.94	12.5	87.5

Conversion of Return Loss to Equivalent VSWR

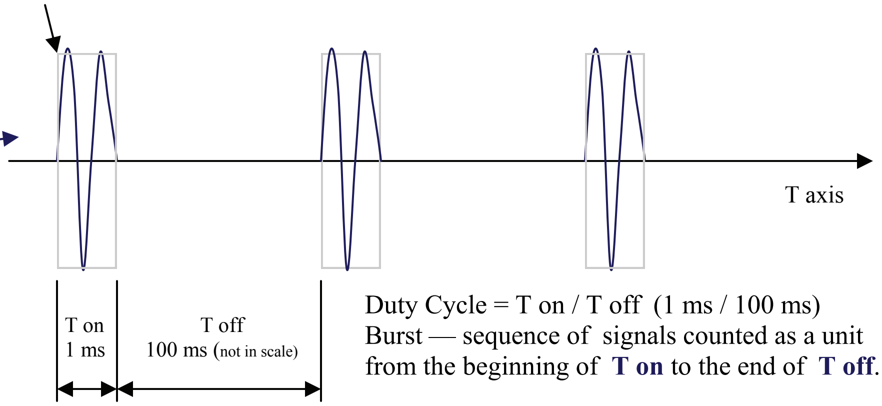
Return Loss (dB)	VSWR	Return Loss (dB)	VSWR
46.1	1.01	19.1	1.25
40.1	1.02	17.7	1.30
36.6	1.03	16.5	1.35
34.2	1.04	15.6	1.40
32.3	1.05	14.7	1.45
30.7	1.06	14.0	1.50
29.4	1.07	12.7	1.60
28.3	1.08	11.7	1.70
27.3	1.09	10.9	1.80
26.4	1.10	10.2	1.90
25.7	1.11	9.5	2.00
24.9	1.12	8.3	2.25
24.3	1.13	7.4	2.50
23.7	1.14	6.6	2.75
23.1	1.15	6.0	3.00
20.8	1.20	5.5	3.25

S.W.R. Calculator



Signal diagram of RF pulses generated by AG series amplifier / generator when TTL/CMOS pulses are applied to the BLANKING Input BNC connector.

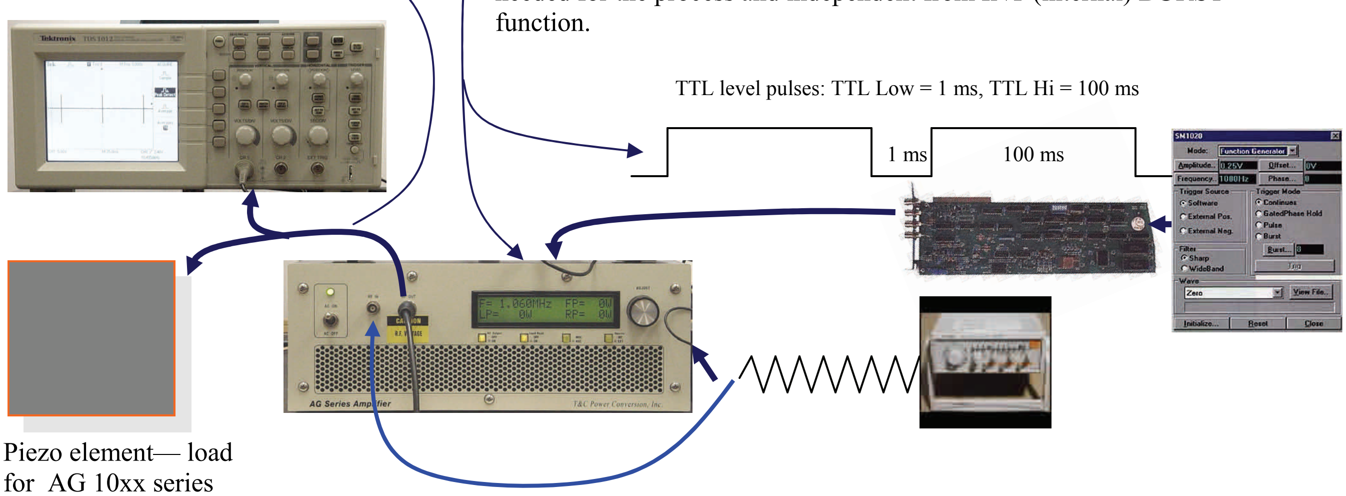
Operating frequency of AG 1021, for example: 1060 kHz. Set from INT source.



Duty Cycle = T on / T off (1 ms / 100 ms)
Burst — sequence of signals counted as a unit from the beginning of **T on** to the end of **T off**.

Application Block Diagram

Blanking IN— your definition of pulses T on and T off — signal from your pulses creating device.
This way you define user-defined Ton and Toff of RF Output any way is needed for the process and independent from INT (internal) BURST function.



Piezo element— load for AG 10xx series amplifier / generator.

EXT. RF IN— your frequency of operation for process — it may be a function generator producing BLANKING signal as requested by process. In this example it is 1060 kHz.
NOTE !
AG 1021 has built-in signal source INT that when used will produce requested frequency . Here it is 1060 kHz.

NOTE ! AG Series amplifier / generator must be set in MGc Mode in order to generate BURST signals. MGc default setting (when switching amplifier to AC ON) is 0%. Changing it from 0% to 100% with Front Adjuster (GUI) produce 0 to nominal RF Output into 50 Ohm load. Please experiment first to find your power and voltage levels in reference to "%" scale. Use this information later when operating in MGc/BURST Modes to set the RF Pulse power and voltage for your process.
This is the only way you may control these levels produced by AG since its Front Panel Meter shows only average power, NOT a pulse power. It is highly recommended to check all measurements with an oscilloscope.

T&C Amplifiers RF Output recommendations.

It is extremely important to understand T&C published specifications and the correct way select an amplifier for the application. Using it wisely within its operating limits will produce the best results and will extend the life of the equipment.

NOTE! The power output capability of an amplifier has absolutely no meaning unless accompanied by the distortion level and the output load impedance specification. Please refer to *OUTPUT POWER AND DISTORTION* from Page 6 for more details outlining this potential issue.

LF Linear Amplifiers and Generators

Model	Linear output (any load)	Typical (max) output into 50 Ω only !	Forward Power FWD Limit	Reverse Power REV Limit
AG 1020	50 W	175 W	175 W of power into 50 Ω or its equivalent signal level into 50 Ω	65 W of equivalent signal level into 50 Ω
AG 1021	100 W	300 W	300 W of power into 50 Ω or its equivalent signal level into 50 Ω	75 W of equivalent signal level into 50 Ω
AG 1017L	200 W	500 W	500 W of power into 50 Ω or its equivalent signal level into 50 Ω	100 W of equivalent signal level into 50 Ω
AG 1015	400 W	1000 W	1 kW of power into 50 Ω or its equivalent signal level into 50 Ω	250 W of equivalent signal level into 50 Ω

LF "B" Class Amplifiers and Generators

Model	Recommended output (any load)	Typical (max) output into 50 Ω only !	Forward Power FWD Limit	Reverse Power REV Limit
AG 1006	150 W	300 W	300 W of power into 50 Ω or its equivalent signal level into 50 Ω	65 W of equivalent signal level into 50 Ω
AG 1016	250 W	600 W	600 W of power into 50 Ω or its equivalent signal level into 50 Ω	80 W of equivalent signal level into 50 Ω
AG 1012	400 W	1000 W	1000 W of power into 50 Ω or its equivalent signal level into 50 Ω	160 W of equivalent signal level into 50 Ω
AG 1024	800 W	2000 W	2 kW of power into 50 Ω or its equivalent signal level into 50 Ω	400 W of equivalent signal level into 50 Ω
AG 1048	1600 W	4000 W	4 kW of power into 50 Ω or its equivalent signal level into 50 Ω	800 W of equivalent signal level into 50 Ω