HIGH LINEARITY AMPLIFIERS

apitech

APITech's talented group of engineers have crafted a selection of amplifiers that meets and exceeds our customers' expectations, and continues to build upon that excellent reputation.

Product Line Overview

Hybrid Components, Mixers & Advanced Technologies

- In-house thin & thick film capability
- 30 year heritage design database
- Quick turn prototypes (2-4 days)
- Complete testing & ESS capability
- Rapid military to low cost conversion
- Modular assemblies

Filter Components & Integrated Filter Assemblies

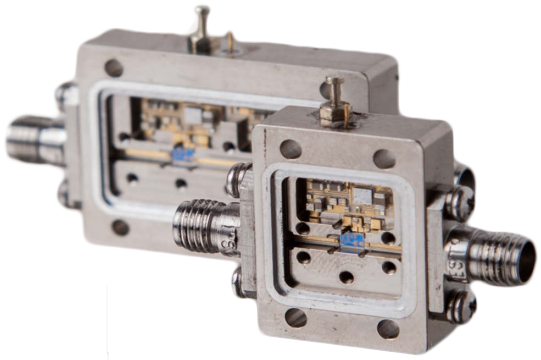
- Complete filter solutions
- In-house machining
- Complete testing & ESS capability
- 20 year heritage design database
- Focused design centers for quick turn prototypes (2-4 weeks)

Frequency Sources & Integrated Microwave Assemblies

- 80% critical component content
- In-house development of ATE
- 25 IMA engineers with 22 years average experience

Engineering for Excellence

- Using the expertise of our team of Microwave Amplifier Design Engineers, our focus is not only on meeting the customer's requirement, but on exceeding their expectations.
- Other companies talk about High Linearity. . .we let our designs speak for themselves.
- For example. . .



Amplifier Designs

- Our Push-Pull Design Techniques, coupled with transistors APITech to achieve this incredible performance including IP2 values of +120 dBm.

In order to understand the benefit's of APITech's outstanding performance, a little background on theory of linearity is in order.

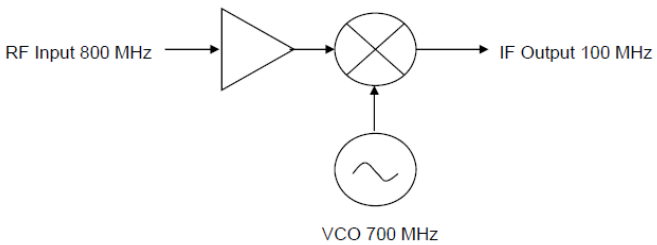
The second-order term can be expanded as:

$$c_2\left(a_1\cos(\omega_1 t)+a_2\cos(\omega_2 t)\right)^2 =$$
$$\left[\frac{c_2 a_1^2}{2}+\frac{c_2 a_2^2}{2}\right]+$$
$$\left[\frac{c_2 a_2^2}{2}\right]\cos(2\omega_1 t)+$$
$$\left[\frac{c_2 a_2^2}{2}\right]\cos(2\omega_2 t)+$$
$$\left[\frac{c_2 a_1 a_2}{2}\right]\left(\cos\left((\omega_1+\omega_2)t\right)+\cos\left((\omega_1+\omega_2)t\right)\right) \quad (5)$$

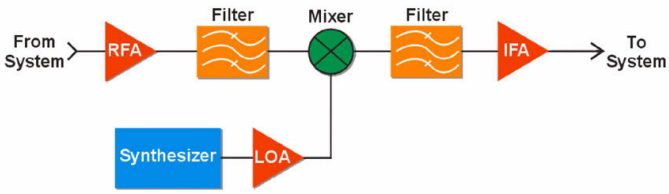
The same trigonometric identity can be used to expand the third-order terms yielding:

$$c_3\left(a_1\cos(\omega_1 t)+a_2\cos(\omega_2 t)\right)^3 =$$
$$\left[\frac{3c_3 a_1^3}{4}+\frac{3a_1 a_2^2}{2}\right]\cos(\omega_1 t)+$$
$$\left[\frac{3c_3 a_2^3}{4}+\frac{3a_1^2 a_2}{2}\right]\cos(\omega_2 t)+$$
$$\left[\frac{c_3 a_1^3}{4}\right]\cos(3\omega_2 t)+$$
$$\left[\frac{c_3 a_2^3}{4}\right]\cos(3\omega_2 t)+$$
$$\left[\frac{3c_3 a_1 a_2^2}{4}\right]\left(\cos\left((2\omega_1+\omega_2)t\right)+\cos\left((2\omega_1-\omega_2)t\right)\right)+$$
$$\left[\frac{3c_3 a_1^2 a_2}{4}\right]\left(\cos\left((2\omega_2+\omega_1)t\right)+\cos\left((2\omega_2-\omega_1)t\right)\right) \quad (6)$$

All superheterodyne receivers utilize an intermediate frequency (IF) between the input of the antenna and the amplification stages. When a single tone is received it is processed so that the signal can be more easily demodulated.

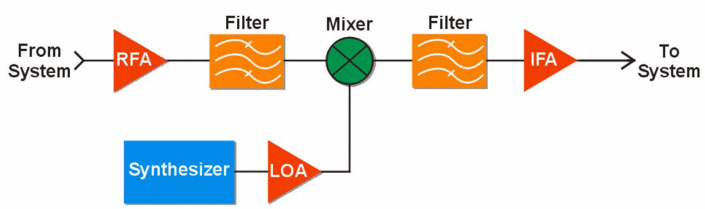


The theoretical third order intercept is determined when we input 2 signals into the input signal port of our receiver.

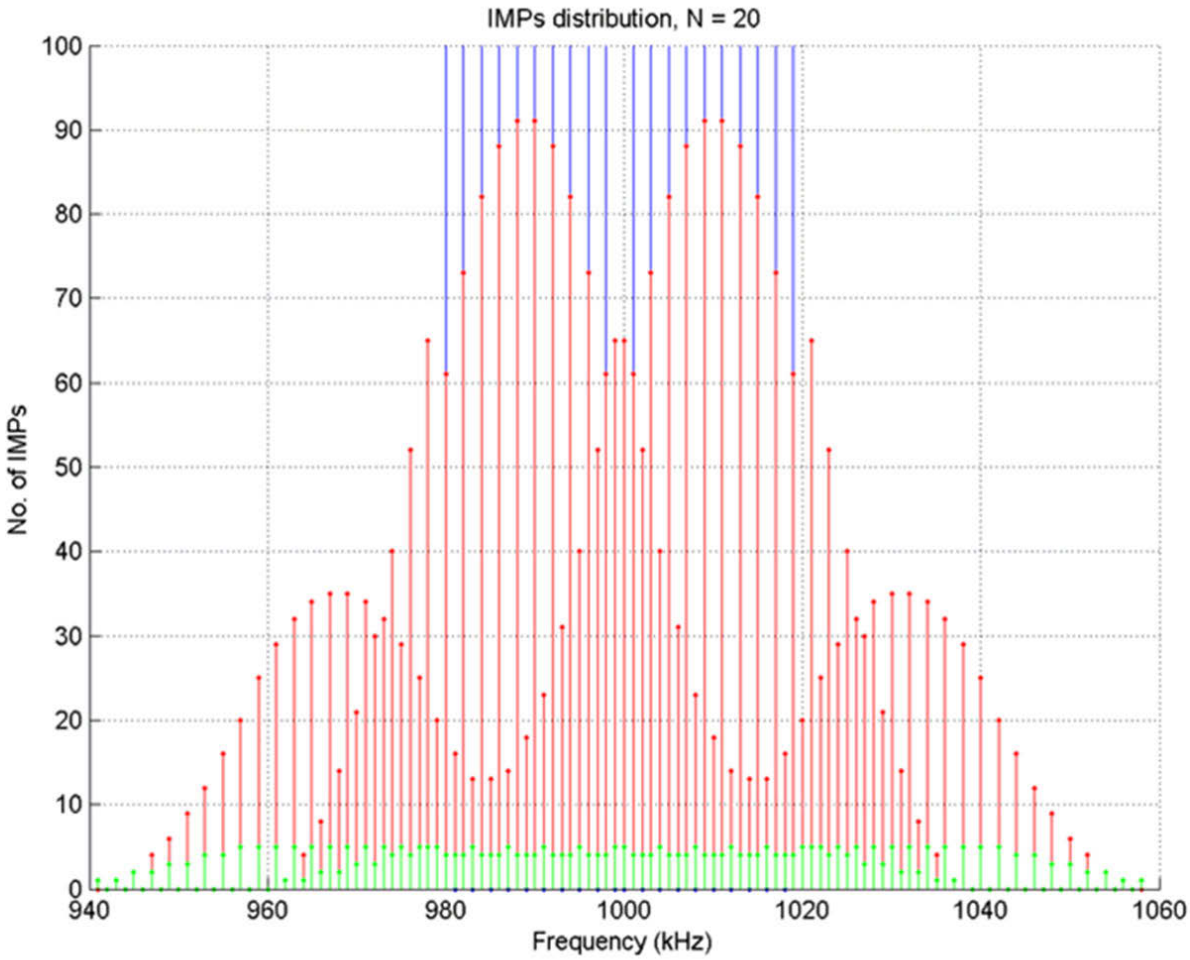


These signals then pass thru a mixer which produces tones that are the differences or sums of those signals referred to as the IM (intermodulation) products.

Some of these tones are within the IF band which will pass right thru the IF amplifier (IFA) which follows this mixer.

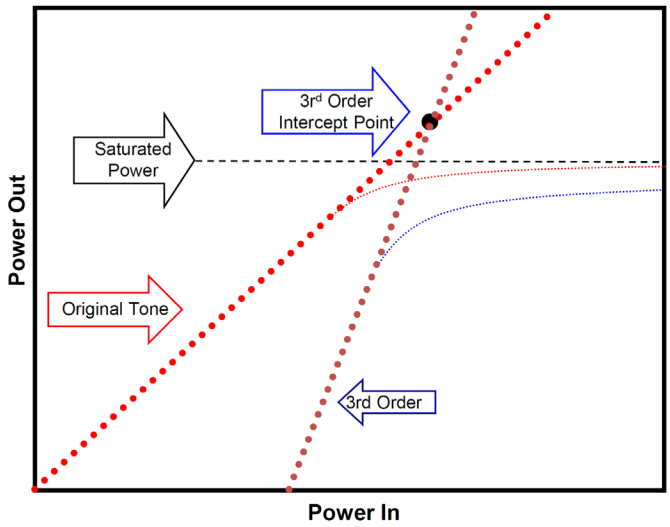


The IM products which play a pivotal role in the signal processing is the 2nd harmonic which is related to the 3rd order tones, which then leads us to the 3rd order intercept.



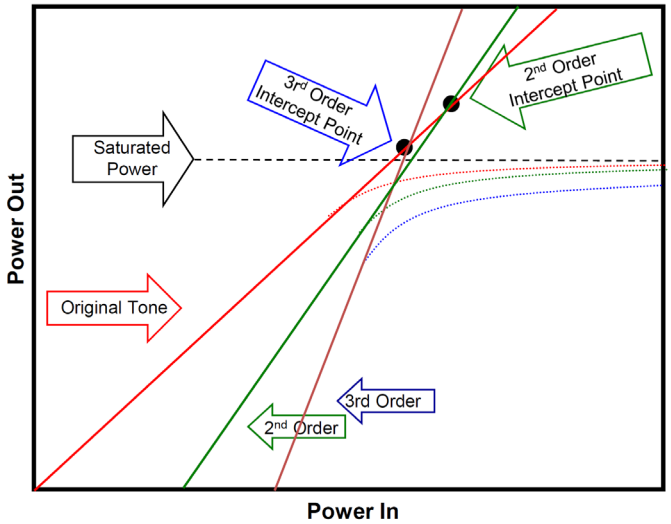
Now, as signal strength is increased by 1 dB, the IM products also increase, but by 3 dB.

The third order intercept point is the output signal level (thru extrapolation) at which the 3rd order tones would achieve an equal amplitude level, as the desired input frequencies.

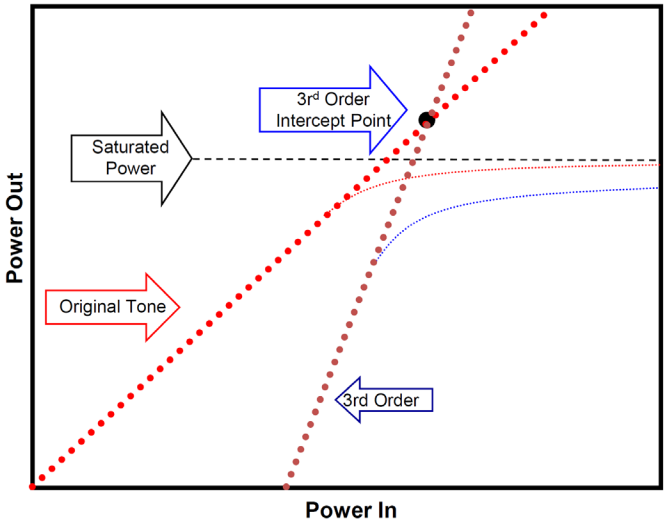


If we reach this theoretical point, our mixer output signal becomes distorted. Thereby, any increase in input signal strength will not generate an increase in output signal strength.

This is a problem, because now, the frequency near the signal we want to detect has distorted the information on the carrier signal. This in turn causes interference susceptibility.

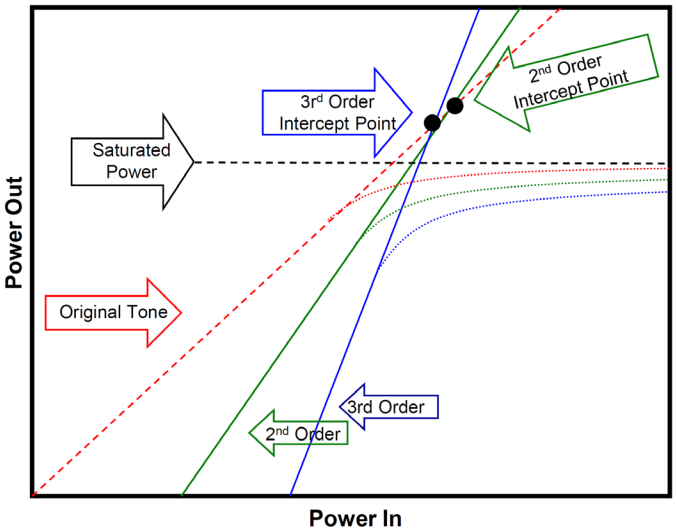


This again goes back to the IM products which cause this distortion, and the noise that follows, and is not a result of the level of our signals.

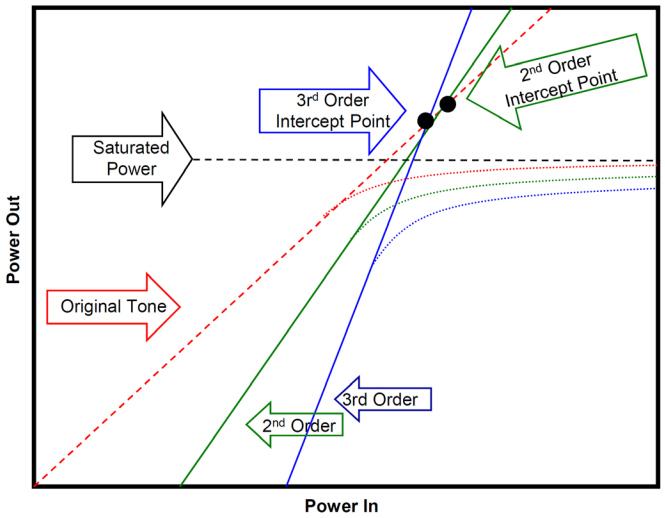


Once again, the third order intercept point is a calculation of the level of our signal vs. that of the unwanted IM products. Higher linearity offers less distortion.

The better the IP3, the more notable the receiver's ability to separate and discern several tones that are processed simultaneously inside our passband.

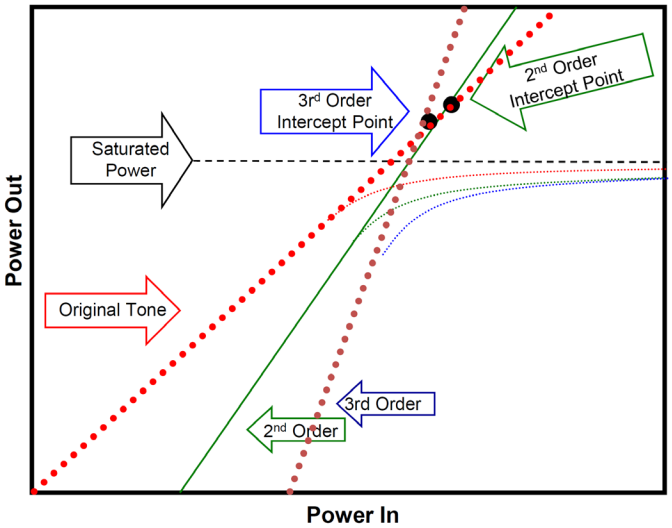


The Third Order Intercept Point is determined by plotting input power vs. the output power. The 2 curves are then drawn, one for a nonlinear product and one for the linear amplified signal.

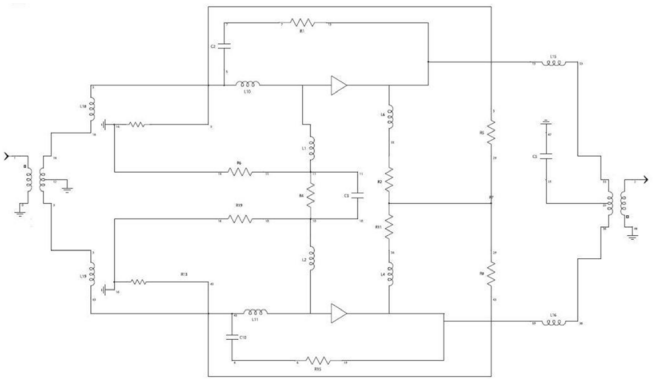


Another way to look at it, the IP3 is a figure of merit that characterizes a receiver's tolerance to several signals that are present simultaneously inside the desired passband.

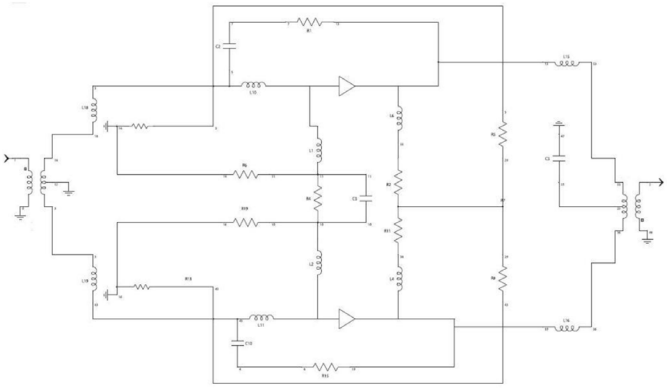
The IP3 is a power level, typically given in dBm, and it is closely related to the 1 dB compression point. Both IP3 and the 1 dB compression point are meaningful only when given in relation to the noise floor.



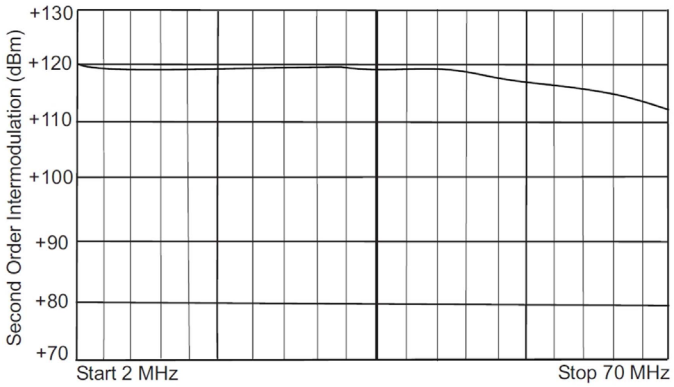
The method to achieve a highly linear circuit is by means of a push-pull design. This is accomplished by splitting the signal through 2 identical amplifiers, then combining the signal at the output end.



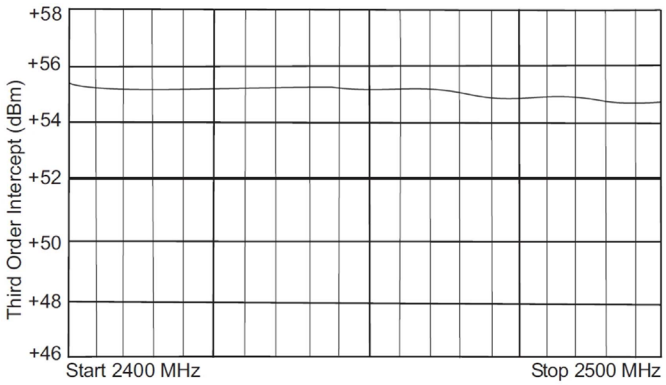
The center tapped transformer at the input end splits the signal evenly, thus the two amplifiers are driven 180 degrees out of phase. After combining the 2 signals at the output transformer, this equal phase shifting transformation creates a cancelling of the even order harmonics, thus generating a cleaner signal.



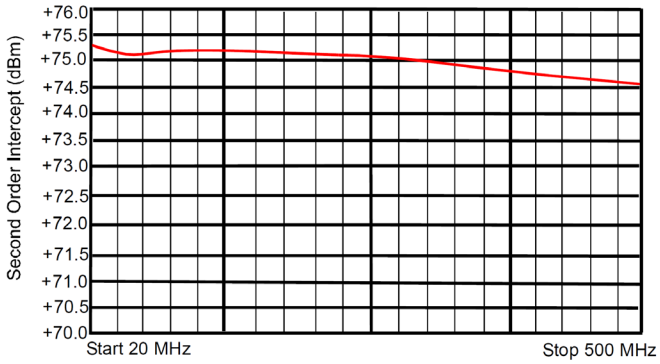
…and Second Order Intercept values like this…



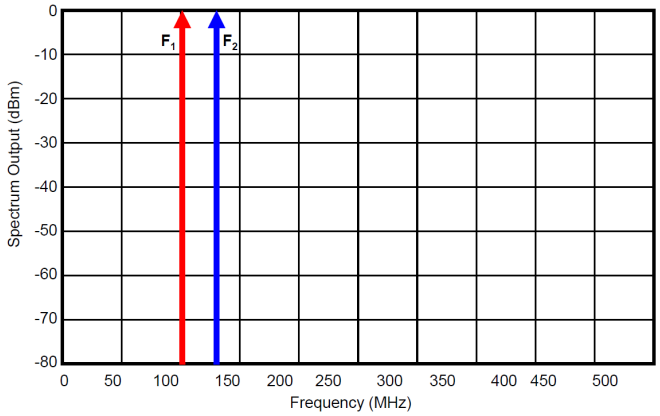
…and consequently IP3 values like this.



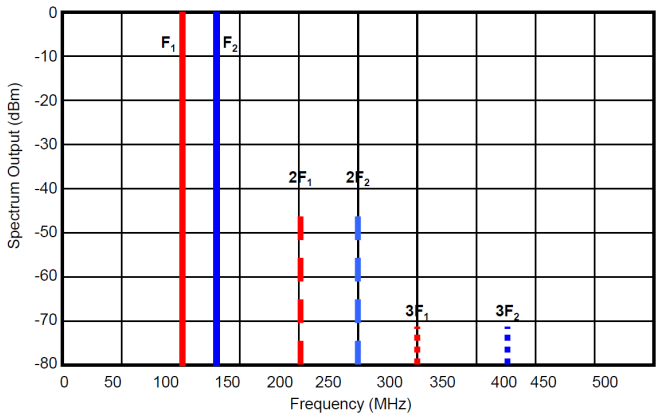
For added savings, our LCA (Lower Cost Amplifier) designs are able to produce IP2 values as high as +75 dBm.



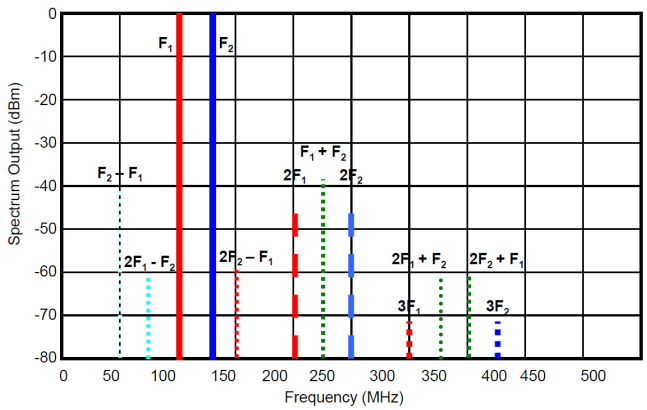
The challenge comes in play when two neighboring signals say a few MHz apart are received. Separating the signals will be a difficult job for the receiver. The higher two neighboring signals will be.

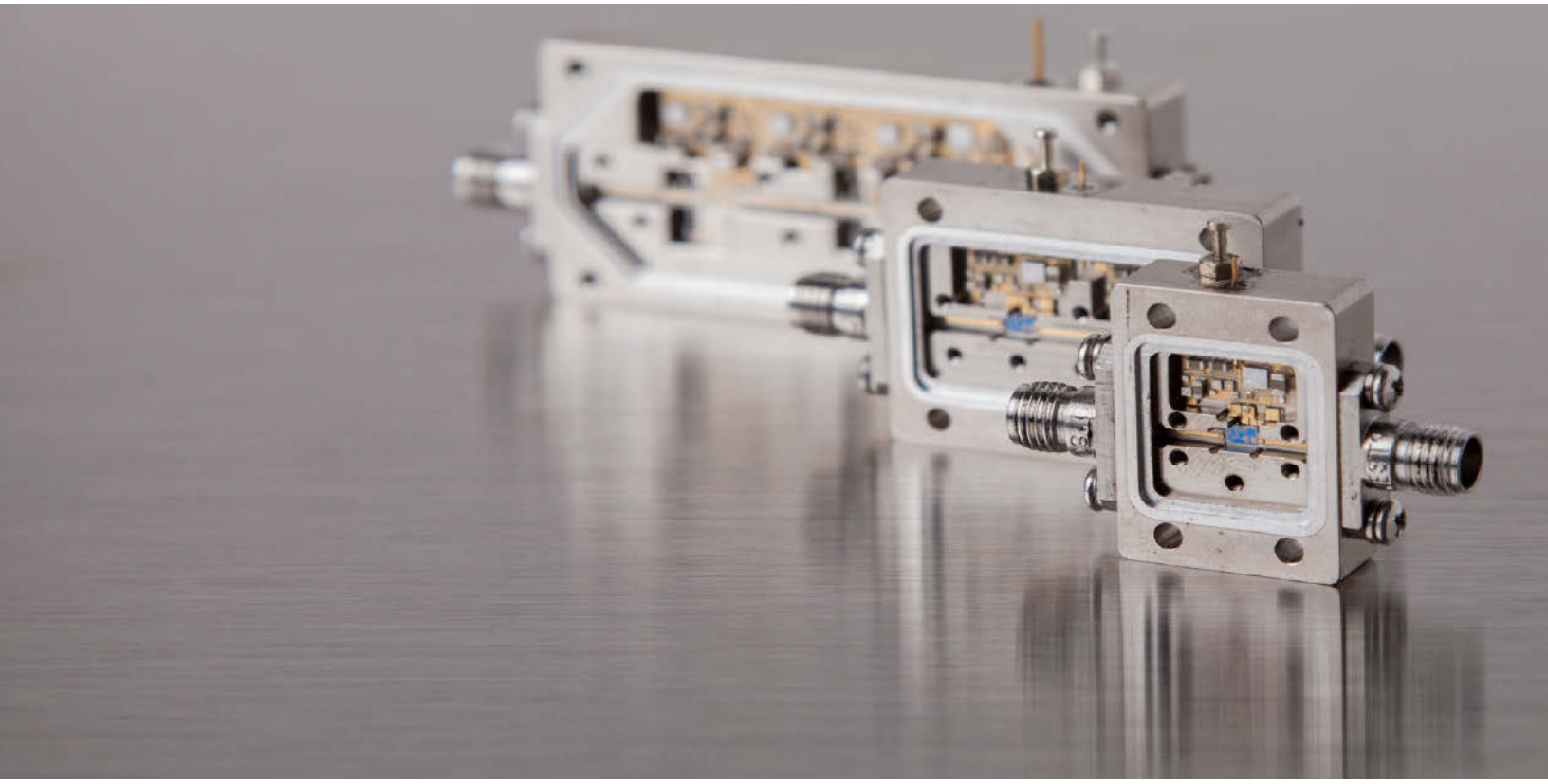


Normally, higher-order products (thirds & seconds) are not seen with the same signal strength as the fundamental frequency. These tones are then viewed and perceived as distortion.



Note that if f_1 and f_2 are tones which are very close to one another (those 2 neighboring tones that were very close to the fundamental frequency), the 2(f_1 -f_2) tones are still close to the f_o. Third and even more difficult second order products are extremely difficult to remove through filtering.



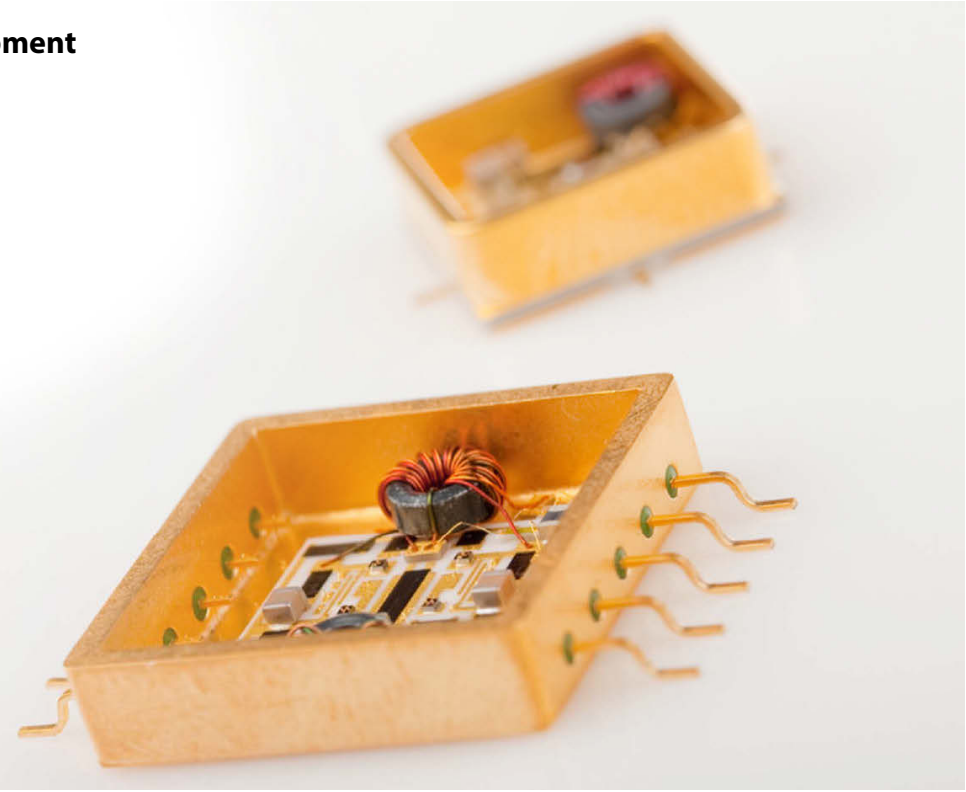


APITech is the industry's High Linearity Specialists

APITech have the experience and expertise to offer the highest performance, highest linearity amplifiers the industry has to offer. We can even customize our design to meet demanding requirements and non-standard package options.

Design & Development Process

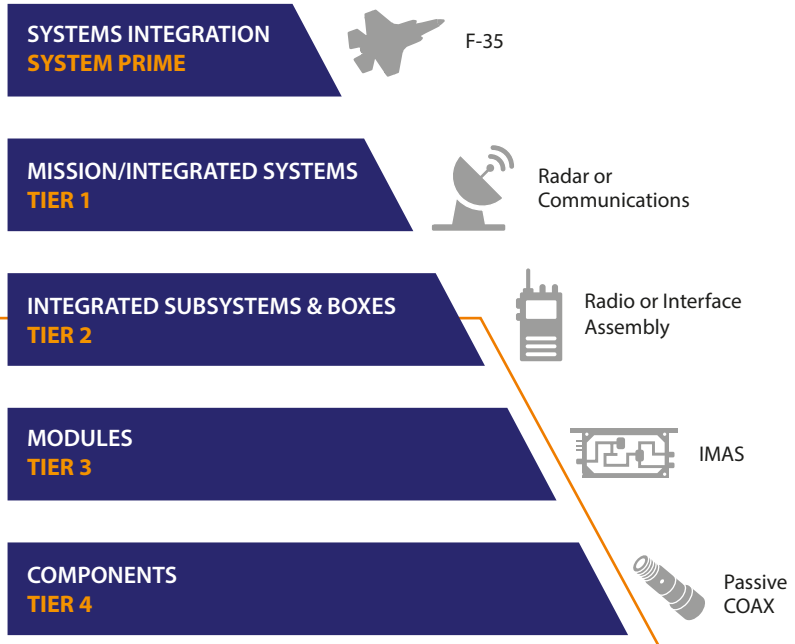
1. **Specification Development**
2. **Simulation & Design**
3. **Prototyping**
4. **Testing**
5. **Manufacturing**
6. **Logistics**



Who We Are

Value-added Integration from Components to Subsystem Solutions

APITech provides rugged, reliable, and efficient subsystems, assemblies, and components for use in the most mission critical defense and military applications, supporting government programs throughout the world. With diverse program experience and preferred supplier status with some of the industry's top premier contractors, our precision-engineered MIL-grade products are ideal for applications where uncompromised reliability and uninterrupted performance is required. APITech is the Electromagnetic Spectrum Innovator at Tier 2.5-4 in the supply chain.



The Electromagnetic Spectrum Innovator

APITech is an innovative designer and manufacturer of high performance systems, subsystems, assemblies and components for technically demanding RF, microwave, millimeter wave, electromagnetic, power, and security applications.

A high reliability technology pioneer with over 70 years of heritage, APITech's products are used by global defense, industrial, and commercial customers in applications spanning radar, electronic warfare, unmanned systems, missile defense, harsh environments, space, communications, medical, test and instrumentation, and more.

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