Two-Tone Transmit IMD Test

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A Transmitter using the Telephony Emission Designator '**2K70J3E**' in the **Upper Side Band (USB)** mode, on a **Carrier Frequency (CF) of 14,155,000 Hz**, modulated by a Two Tone **Audio Frequency (AF) of 700 Hz and 1900 Hz**, would have the following two **Mixed Frequencies (F1 and F2):**

F1 = 14,155,000 Hz (CF) + 700 Hz (AF) = 14,155,700 Hz (MF)
F2 = 14,155,000 Hz (CF) + 1900 Hz (AF) = 14,156.900 Hz (MF)

Note: *Emission Designator 2K70J3E is, Single Side Band Suppressed Carrier - Amplitude Modulation (SSBSC-AM) Telephony, using either the 'Upper Side Band (USB) or 'Lower Side Band (LSB) mode.*
Note: In accordance with extensive testing for almost a century by Bell Laboratories, True Intelligence in the Voice Communication Spectrum is 300 Hz ~ 3000 Hz.

As a standard, the chosen Two Audio Frequency (AF) Tones, ***must*** be between 300 Hz ~ 3000 Hz and Non-Harmonically related to each other, with at least a 1000 Hz separation between them. F1 and F2 can be either Audio Frequency (AF) tone with the same results.

Intermodulation Distortion (**IMD**) products are caused by mixing of **Even-Order Harmonics** and **Odd-Order Harmonics**, which creates new undesired frequencies. Odd Order mixing of the F1 and F2 Frequencies would generate the following **Odd-Order IMD**:

ITEM	Carrier Frequency (CF)	Audio Frequency (AF)	Mixing	Mixed Frequency (MF)	Notes:
F1	14,155,000	700	CF + AF	14,155,700	Above Carrier
F2	14,155,000	1,900	CF + AF	14,156,900	Above Carrier
Odd-Order Intermodulation Distortion (IMD) 'Above / Below' the Carrier Frequency					
	IMD Formula	**F1 Mix**	**F2 Mix**	**F1 Mix - F2 Mix**	**Notes:**
IM9	(5 x F1) - (4 x F2)	70,778,500	56,627,600	14,150,900	Below Carrier
IM7	(4 x F1) - (3 x F2)	56,622,800	42,470,700	14,152,100	Below Carrier
IM5	(3 x F1) - (2 x F2)	42,467,100	28,313,800	14,153,300	Below Carrier
IM3	(2 x F1) - (1 x F2)	28,311,400	14,156,900	14,154,500	Below Carrier
Carrier Frequency =14,155,000					
Odd-Order Intermodulation Distortion (IMD) 'Above / Below' the Carrier Frequency					
	IMD Formula	**F2 Mix**	**F1 Mix**	**F1 Mix - F2 Mix**	**Notes:**
IM3	(2 x F2) - (1 x F1)	28,313,800	14,155,700	14,158,100	Above Carrier
IM5	(3 x F2) - (2 x F1)	42,470,700	28,311,400	14,159,300	Above Carrier
IM7	(4 x F2) - (3 x F1)	56,627,600	42,467,100	14,160,500	Above Carrier
IM9	(5 x F2) - (4 x F1)	70,784,500	56,622,800	14,161,700	Above Carrier

Even-Order mixing products are generated, they just tend to be out-of-band for most RF applications. The Even Second-Order products fall at the sum and difference of the two tones or at **(F2 + F1 = 28,312,600 Hz)** and **(F2 – F1 = 1,200 Hz).**

The **'Odd-Order IMD'** frequencies are “OUTSIDE” the Band Width (BW) occupied by the two desired pure **F1** and **F2** frequencies. This bothers other operators up or down the band from the Carrier Frequency (CF).

ALL 'Odd-Order IMD' products (IM3, IM5, IM7, IM9, etc.) add Band Width (BW) to the signal that is outside the Passband of the original audio, spreading unwanted and undesirable distortion energy throughout adjacent frequencies, which creates most of the problems.

Rules of thumb for Intermodulation Distortion (IMD) Band Width (BW):

1. The maximum frequency spacing of IMD products is the difference between the lowest and highest pitched Audio Frequency (AF) modulating the transmitter.

2. The total Band Width (BW) occupied by an SSBSC-AM signal, when we include IM3 products, is approximately three times the Audio Frequency (AF) Band Width (BW) of the system.

3. The Band Width (BW) of the Transmit Band Pass Filter (BPF) does not set the Band Width (BW) of the signal.

4. Any increase in frequency difference between the highest and lowest modulation frequency increases Band Width (BW) greatly. Any increase in level increases the strength of the IMD product in even greater proportion than we might expect**.**