RF Circuit Design 習題四 2025/04/07

1. 請利用歸納法推導 N 個串接 RF 模組的

a) 總雜訊指數為

$$F_{total} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \ldots + \frac{F_{n+1} - 1}{G_1 G_2 .. G_n}$$

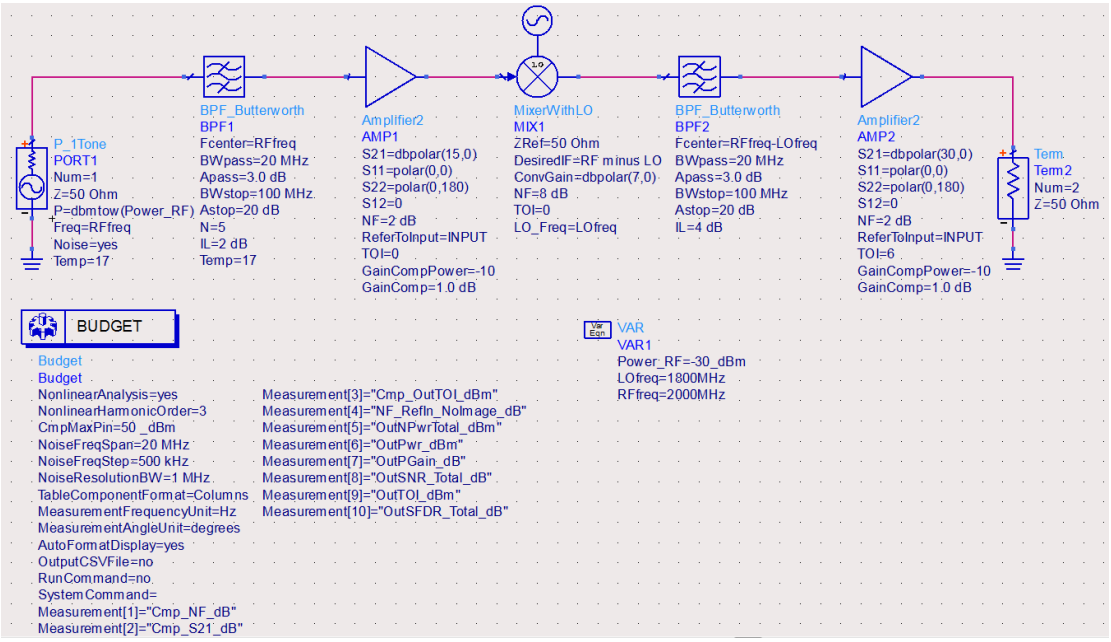
b) 輸出端的 OIP2 及 OIP3

$$\mathrm{OIP2} = -20\log\left[\sum_{i}^{n}\sqrt{\frac{1}{\mathrm{OIP2}_i \mathrm{G}_{i+1}\mathrm{G}_{i+2}\cdots\mathrm{G}_n}}\right] \quad i = 1\cdots n,$$

$$\mathrm{OIP3} = -10\log\left[\sum_{i}^{n}\sqrt{\frac{1}{\mathrm{OIP3}_i \mathrm{G}_{i+1}\mathrm{G}_{i+2}\cdots\mathrm{G}_n}}\right] \quad i = 1\cdots n,$$

其中 G_i，$OIP2_i$、$OIP3_i$、與 F_i 為第 i 級的增益、輸出端二階、三階交叉點及雜訊因素。

2. 本題為 ADS 接收鏈接預算(Link Budget)，1,2,3 為 component 本身，請計算驗證下列:



Meas_Name	BPF1	AMP1	MIX1	BPF2	AMP2
Cmp_NF_dB	2.001	2.000	8.000	4.000	2.000
Cmp_S21_dB	-2.000	15.000	7.000	-4.000	30.000
Cmp_OutTOI_dBm	1000.000	15.000	7.000	1000.000	36.000
NF_RefIn_NoImage_dB	2.001	4.001	4.438	4.461	4.484
OutNPwrTotal_dBm	-101.213	-84.099	-75.320	-79.304	-49.286
OutPwr_dBm	-32.000	-17.005	-10.180	-14.180	15.626
OutPGain_dB	-2.000	12.995	19.820	15.820	45.626
OutSNR_Total_dB	69.213	67.093	65.140	65.123	64.913
OutTOI_dBm	1000.000	15.000	6.865	2.865	31.145
OutSFDR_Total_dB	1000.000	66.066	54.790	54.779	53.621

(4)列為 Cascade Noise Figure，(5)列為 Output Noise Power(Amp1 output) ，(6) 列為 Output Power，(7)列為 Output Power Gain，(8)列為 SNR, (9)列為 Cascade OIP3，(10)列為 SFDR。若有不符之處請說明你的觀點。(註:可用軟體算但最好用筆算)

3. 請根據下面提供的標準3GPP TS 05.05繪出PCS-1900小型行動台(MS)的阻擋信號功率對頻偏的作圖(頻率軸只要示意即可不一定按尺寸) 並請註明載波在頻帶中央與頻帶邊緣有何差異及要注意的地方。

(A) Frequency Band:

Frequency band	Frequency range (MHz) DCS 1 800	
	MS	BTS
in-band	1 785 - 1 920	1 690 - 1 805
out-of-band (a)	0,1 - 1705	0,1 - < 1 690
out-of-band (b)	> 1 705 - < 1 785	N/A
out-of band (c)	> 1 920 - 1 980	N/A
out-of band (d)	> 1 980 - 12,750	> 1 805 - 12,750

Frequency band	Frequency range (MHz)	
	PCS 1 900 MS	PCS 1 900 & MXM 1900 BTS
in-band	1910 - 2010	1830 - 1930
out-of-band (a)	0,1 - < 1830	0,1 - < 1830
out-of-band (b)	1830 - < 1910	N/A
out-of band (c)	> 2010 - 2070	N/A
out-of band (d)	> 2070 - 12,750	> 1930 - 12,750

(B) Blocking Characteristics:

The blocking characteristics of the receiver are specified separately for in-band and out-of-band performance as identified in the following tables.

Frequency band	GSM 400, P-, E- and R-GSM 900						DCS 1 800 & PCS 1 900			
	other MS		small MS		BTS		MS		BTS	
	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm
in-band										
600 kHz ≤ $\|f-f_o\|$ < 800 kHz	75	-38	70	-43	87	-26	70	-43	78	-35
800 kHz ≤ $\|f-f_o\|$ < 1,6 MHz	80	-33	70	-43	97	-16	70	-43	88	-25
1,6 MHz ≤ $\|f-f_o\|$ < 3 MHz	90	-23	80	-33	97	-16	80	-33	88	-25
3 MHz ≤ $\|f-f_o\|$	90	-23	90	-23	100	-13	87	-26	88	-25
out-of-band										
(a)	113	0	113	0	121	8	113	0	113	0
(b)	-	-	-	-	-	-	101	-12	-	-
(c)	-	-	-	-	-	-	101	-12	-	-
(d)	113	0	113	0	121	8	113	0	113	0
NOTE: For definition of small MS, see subclause 1.1.										

Blocking Level