# ABOUT ONE EXPERIMENTAL MODULUS HAVING EXCITED THE PARAMETRIC PHENOMENA BY LOW PUMPING FREQUENCY

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**Abstract:** In this paper, we are reporting new experimental results about the parametric resonances at various regions of low pumping frequencies, N = 3, 5, 7, 9, $N=2\varpi_0/p$, (where p is low pumping frequency, $\varpi_0$ is the resonance fryquency of system) and characteristics of that system. These experimental results can take important part in theoretical calculation and application at ultra-high frequency field.

Experimentally, many groups of researchers have studied parametric generations and amplifications using low pumping frequency as applying method of mixing of frequencies (between two low pumping frequencies) or doubling pumping frequencies (using the second-order harmonic of the pumping frequency $f_b$) to product a high pumping frequency [1,2,3]. In general, almost all parametric generators and amplifiers use single parametric generation and amplification ($f_b = 2f_0$, $f_0$ - resonant frequency) or follow Manley-Rowe relation having tie of relations of frequencies.

In those cases, the pumping frequency is often higher than one of the two resonance frequencies of the system. It is greatly difficult to use parametric generation at the ultra-high frequency band, because it is hard to generate the pumping frequency higher than the signal one.

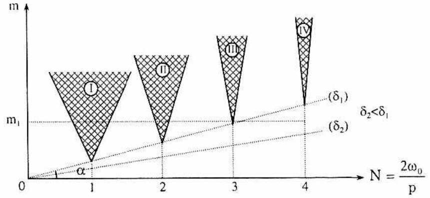


**Fig.1.** Parametric exciting regions (dissipative case, $\delta \neq 0$, m - mudulating coefficient)

However, theoretical studies indicated that regions, which might be able to excite parametric generation by using a low pumping frequency, is prompted by Hill's or Mathieu's equations. (Fig.1: the region I, N = 1, $f_b = 2f_0$; the region II, N = 2, $f_b = f_0$; the region III, N = 3, $f_b = (2/3)f_0$; the region IV, N = 4, $f_b = (1/2)f_0$; N = 5, fb = $(2/5)f_0$;...).

Some authors assumed that the parametric exciting regions corresponding to $N \geq 2$ have few applications in practice [4]. So, following us, there are no experimental publications about parametric exciting capacity of these regions. On the other hand, even at the parametric generating region $N = 2$ ($f_b \approx f_0$), the resonance is said to "bully" the parametric phenomenon. And with other N-even regions that have not considered yet, to want to excite the parametric phenomenon, it is necessary to have an non-symmetrical pumping source (square pulse pumping). With N-odd regions (N=1,3,5...), only by pumping pulse (symmetrical or non-symmetrical) or sinusoidal can transmit energy into the system.

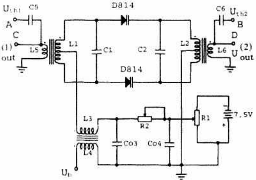


**Fig.2.** Experimental diagram

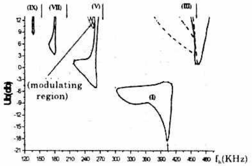


**Fig.3.** Parametric exciting regions of the main circuit by low pumping frequency

To use a sinusoidal pumping, we used a experimental modulus like a two contour parametric generator in which the high frequency contour (the contour II) is chosen to be the main one and the low frequency contour (the contour I) is considered as the secondary one. From then, we excited N-odd parametric regions N = 3, 5, 7, 9 (Fig. 2).

In the experiment, we linked shortly circuit II like a single parametric generator creating a positive feedback through a field effect transistor (FET) to be able to increase the Q-factor of the contour I to 500. Even then, it is impossible to excite parametric oscillations at regions N = 3, 5, 7 (sinusoidal pumping, varied-$f_b$ and $U_b$). Because of the existence of the contour I (although having no positive feedback, $Q_1$ and $Q_2$ were not rather high), parametric generating regions corresponding to $f_b=\{2/3,2/5,2/7,2/9\}f_{20}$ can be excited, shown in the Fig. 3 (the downward arrow defines generating regions satisfying $f_b = \{2/3,2/5,2/7,2/9\}f_{20}$).

In the region III, $f_b = (2/3)f_{20}$, there are three signal periods corresponding to each two pumping periods. The region III is more narrow than the region I (N = 1) and the width of this region gradually increases (about 37 KHz at +13db). There might be able to have amplitude delay at the left of the region III. The amplitude Uout(2) is rather high comparing with the pumping.

The region V (N = 5, $f_b = (2/5)f_{20}$) at U=b = +13db (about 3.1V) is narrow about (8÷10)KHz and sloping at two its boundaries. When $U_b$ reduces under $U_b \leq (2÷3)$db, this region become larger. $U_b^N$ is low under (- 5.1)db (about 0.325V). With other values of $C_1$, $C_2$ ($C_1$ = 337pF, $C_2$ = 12.6pF), the under part of the region V will be swollen.

The region VII ($f_b = (2/7)f_{20}$, is more narrow and its form is similar to region V, but its down-threshold is higher ( $U_b^N$ = 3.4db, about 1V).

The region IX, $f_b = (2/9)f_{20}$, is very narrow (its width is about 1 KHz) , $U_b^N$ = 8.4 db (about 1.7V). At $U_b$ = 13 db, the region is shrunk and it is possible to have the up-threshold if $U_b$ > 13 db.

## Conclusions

N-high generating regions are rather stable, it can be able to measure repeatedly at different times.

When fixing $f_{10}$, $f_{20}$, with different frequencies such as $f_b$ = 460 KHz; 260 KHz; 180 KHz; 138 KHz corresponding to certain pumping voltages $U_b$ all excite at the same frequency $f_2 \approx f_{20}$ = 694 KHz. Realize clearly the role of the contour I to affect the capacity of parametric generation and amplification at frequencies which are higher than the pumping frequency.

Also observed two modulating regions located at the left of the generating regions III and V ($U_b$ = 13db, at the frequency bands of (377 ÷ 418) KHz and (245 ÷ 259) KHz) but its causes has not studied carefully yet.

With high pumping amplitude without bias voltage ($E_0$ = 0V), above the zero-decibel-level (about 0,66V), can observe frequency multiplying regions among generating regions, such as frequency doubling, frequency three-multiplying or four-multiplying.

It is necessary to study the influence of the secondary contour I to the capacity of parametric generation and amplification on the base of their ties of phase relations. And other feature is always to have coherence among exciting modes on the Litssajuos imagines, even when comparing the output amplitude $U_{out}^{(1)}$ with the pumping one or comparing $U_{out}^{(1)}$ and $U_{out}^{(2)}$.

It is impossible to observe the capacity of low frequency parametric generation when the high contour II is chosen to be secondary contour.

## References


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