Chapter 5

BJT FIFTH-HARMONIC PEAKING CLASS F POWER AMPLIFIER

1. ESB STRUCTURE AS AMPLIFIER OUPUT NETWORK

The fifth-harmonic peaking class-F power amplifier operated at 1GHz was designed using the presented in Chapter 4 double-period microstrip ESB structure. The three-section ESB was used as the output network. Equivalent circuit of the amplifier concerned is shown in Fig. 5-1.

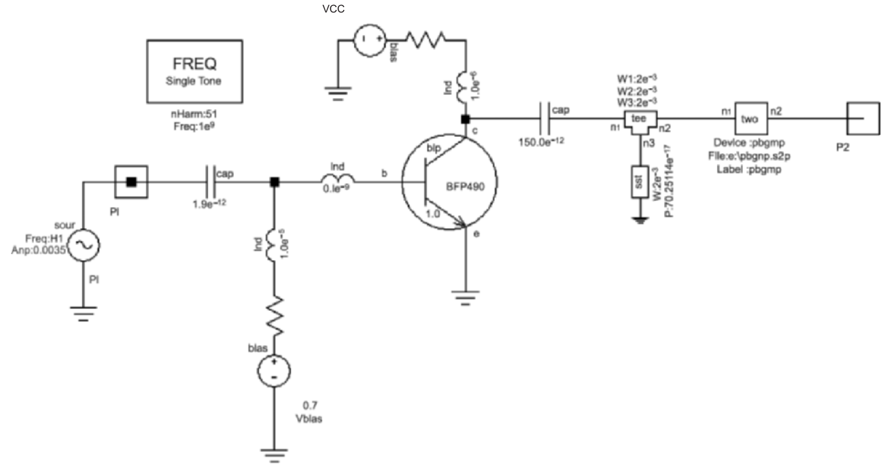

Figure 5-1. The equivalent circuit of fifth harmonic peaking class-F power amplifier.

Table 5-1. BFP-490 model parameters[*]

Parameter	Value	Parameter	Value
bf	114.96	nc	1.339
br	21.04	ne	1.9962
cbc	2.2fF	nf	1.1472
cbe	150.0fF	nr	1.3531
cce	500.0fF	ptf	0.0
cjc	6.1521fF	rb	2.1262
cje	1.227fF	rbm	1.0754
eg	1.11	rc2	0.10737
ikf	0.76939	re1	0.32476
ikr	0.09033	tf	3.9147ps
irb	0.17683mA	tnom	300
is	0.451fA	tr	1.115ns
isc	3.7479fA	va	24.665
ise	1.591fA	vb	16.035
itf	3.2793mA	vjc	0.9832
lb	1.15nH	vje	0.93266
lc	0.59nH	vtf	0.27348
le	0.19nH	xcjc	0.3
mjc	0.34153	xtb	0.0
mje	0.36885	xtf	0.61664
name	BFP490	xti	0.0

[*] Other parameter fields should be remained blank.

The BJT BFP490 model parameters[45] are given in Table 5-1.

The microstrip double-period structure was represented as the two-port with known S-parameters for simulation using Serenade SV8.5 package. The shorted section of original microstrip line was used for tuning of output network's input impedance.

2. SIMULATION RESULTS

The magnitude of output network's input impedance with shorted section versus frequency is shown in Fig. 5-2. Its value at the fundamental frequency is equal to the critical resistance that allows the maximum power ability without saturation.

The input impedance magnitudes for the third and the fifth harmonics are substantially higher than the fundamental frequency value (see Fig. 5-2). These are the mandatory conditions to underline third and five harmonics in the output voltage, and to achieve target flat signals' waveforms.

The simulated collector current's and collector-emitter voltage's waveforms are shown in Fig. 5-3. As can be seen, collector-emitter voltage has smoothed bottom leading to dissipated power decreasing and efficiency increasing.

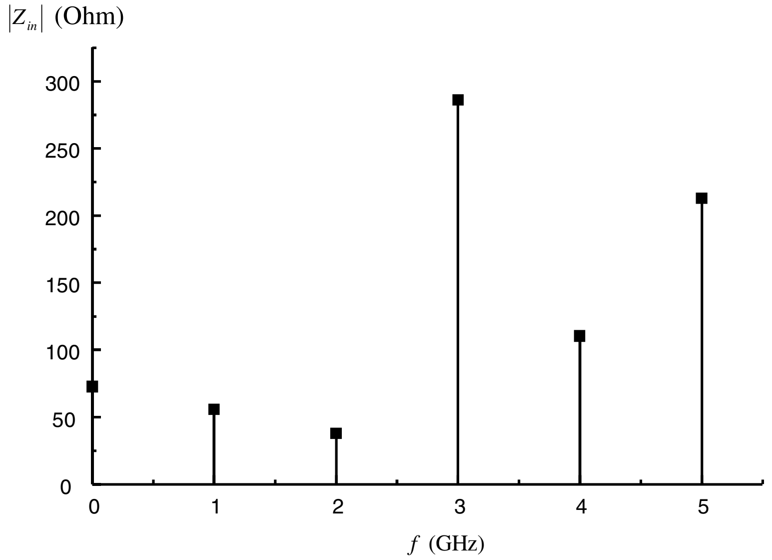

Figure 5-2. The magnitude of output network input impedance.

The collector efficiency was as high as 78.6% along with PAE equal 78.2%. The achieved result is 4.7% less than maximally possible 83.3% for the case of fifth-harmonic peaking[14]. It can be explained by non-zero minimum collector-emitter voltage, that needs to avoid saturation. The 83.3% value was obtained for zero minimum voltage case.

The amplitude characteristics of amplifier's efficiency and output power are shown in Fig. 5-4. The efficiency is above the 70% for the driving signal power greater then 2mW. The output power is the monotonically increasing function, while efficiency has a flat maximum at the 3.75mW driving power point.

The amplifier output power and efficiency versus frequency are shown in Fig. 5-5. The collector efficiency is above 60% within more than 300 MHz frequency band. The output power varies from 180mW to 280mW at the 960MHz and exceeds the 240mW value within 200MHz frequency band.

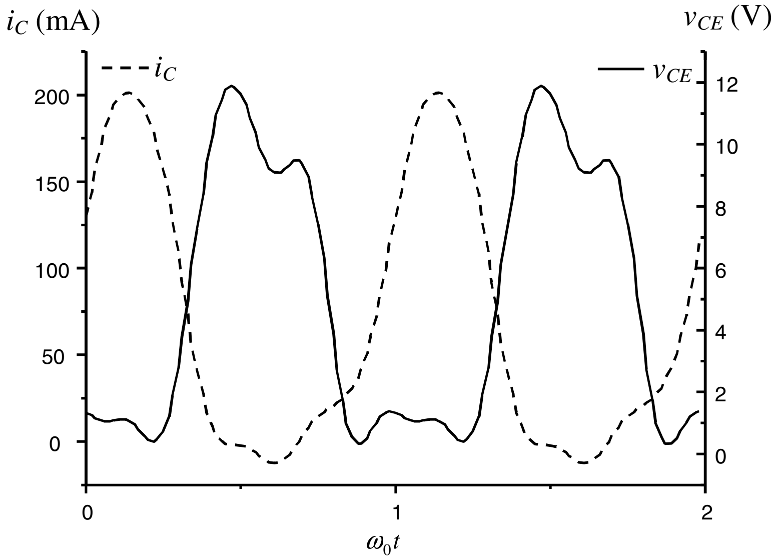

Figure 5-3. Collector current and collector-emitter voltage waveforms.

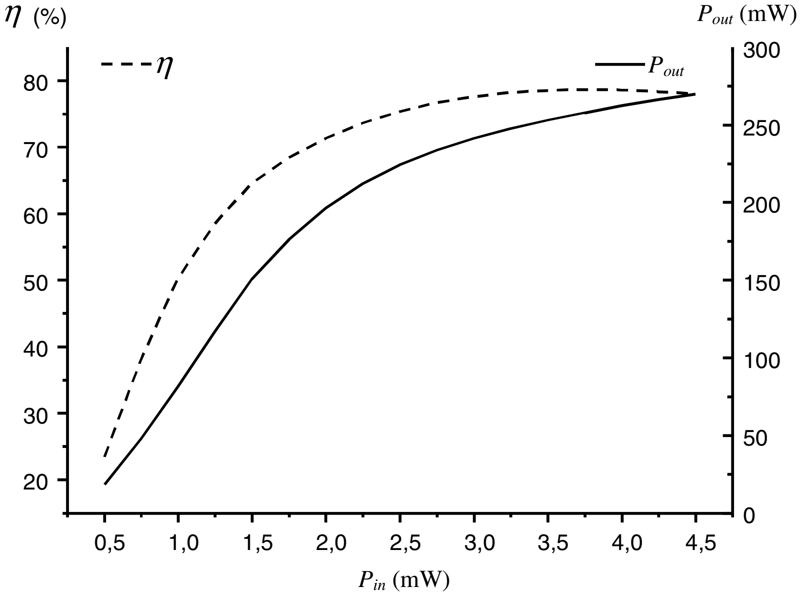

Figure 5-4. Amplitude characteristics of amplifier's output power and efficiency.

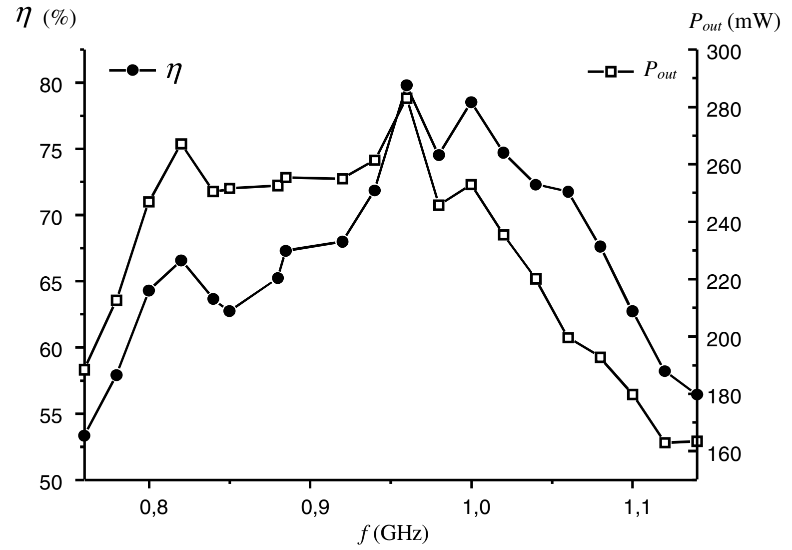

Figure 5-5. Frequency characteristics of amplifier's output power and efficiency.

3. SUMMARY

The results presented show the advantages of use of the double-period structures as output networks of polyharmonic power amplifiers. Due to the acceptable characteristics both in the pass band and in the rejection band, the ESB network allows to achieve high efficiency within wide frequency band.