

定: $Q_L/Q_0 \downarrow$, $\eta_{\max} \uparrow$; 若 Q_0 选定时, $Q_L \downarrow$, $\eta_{\max} \uparrow$, 但 $\Delta \downarrow$ 。

(二) 統調的計算:

说明:

- (1) 由于本计算公式是新的, 有必要将推导过程列出, 以供同志们参考或纠正;
- (2) 本计算公式是由一般形式的振荡回路到特殊的振荡回路推出的, 因此它适用于振荡回路的不同接法的计算。

(3) 本计算公式既适用于双连电容器为等容量变化曲线的, 也适用于双连为不等容(差容)的。但是计算后一种情形时, 必须先测量并作出它的角度与容量的关系曲线, 如图 8。

(4) 本计算方法与别的不同仅仅在于振荡回路的计算, 输入回路按一般计算。

1. 输入回路的计算公式:

已知量:

- f_{\min} ——波段的最低频率;
- f_{\max} ——波段的最高频率;
- $C_{R\min}$ ——双连的输入回路组最小容量;
- $C_{R\max}$ ——双连的输入回路组最大容量;
- f_1, f_2, f_3 ——自己取定的三点统调频率。

计算公式如下:

波段盖系数的平方值 k^2 :

$$k^2 = \frac{f_{\max}^2}{f_{\min}^2};$$

并联电容 C_L (包括各种杂散电容在内):

$$C_L = \frac{C_{R\max} - k^2 C_{R\min}}{k^2 - 1};$$

输入线圈电感量 L_R :

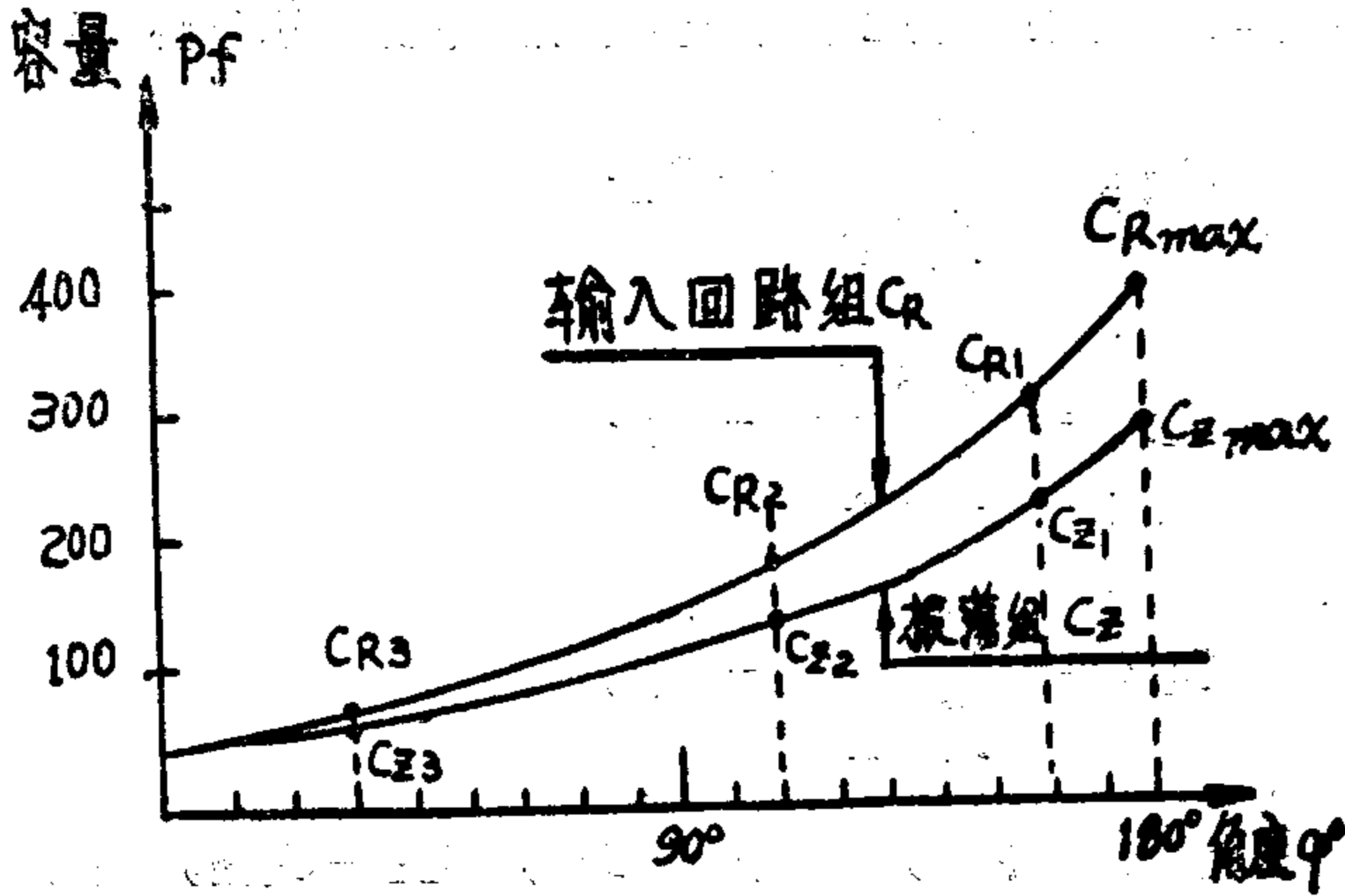


图 8 差容可变出容器的 $Pf \sim \varphi^\circ$ 关系曲线

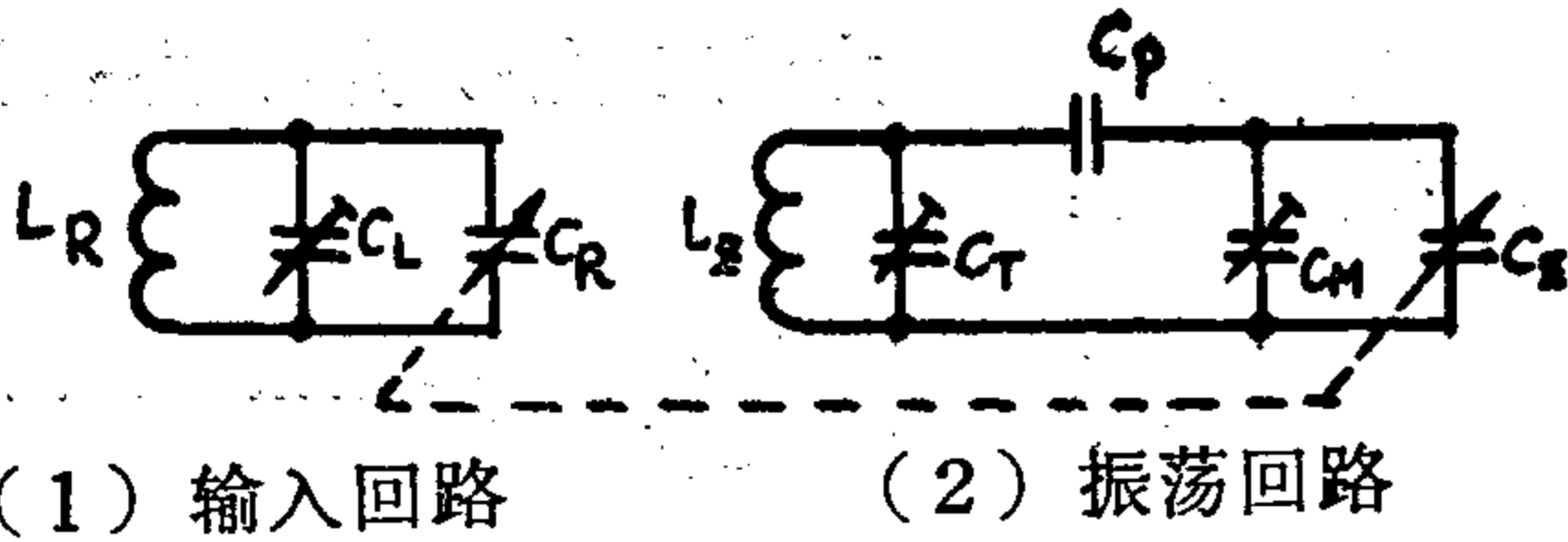


图 9 一般情形的超外差统调回路

$$L_R = \frac{25330}{f_{\min}^2(C_{R\max} - C_L)},$$

式中: $C_{R\max}$, C_L —Pf, f_{\min} —MC, L_L — μh 。

2. 振荡回路计算公式的推导:

已知量: 对应于三点统调频率 f_1 , f_2 , f_3 的三个振荡频率 f_{z1} , f_{z2} , f_{z3} ,

可算出的量: 对应于 f_{z1} , f_{z2} , f_{z3} 的 C_{z1} , C_{z2} , C_{z3} 。算法如下:

$$C_{R1} = \frac{25330}{f_1^2 L_R} - C_L;$$

$$C_{R2} = \frac{25330}{f_2^2 L_R} - C_L;$$

$$C_{R3} = \frac{25330}{f_3^2 L_R} - C_L。$$

若双连为等容的, 则 $C_{z1} = C_{R1}$, $C_{z2} = C_{R2}$, $C_{z3} = C_{R3}$;

若双连为差容的, 则可由算出的 C_{R1} , C_{R2} , C_{R3} 按图 8 找出对应同一角度的 C_{z1} , C_{z2} , C_{z3} 。

我们假定 C_1 , C_2 , C_3 为对应 f_{z1} , f_{z2} , f_{z3} 时振荡回路的总电容, 则可对振荡回路列出如下电容方程:

$$C_1 = \frac{(C_{z1} + C_M)C_P}{(C_{z1} + C_M) + C_P} + C_T \dots\dots\dots(1)$$

$$C_2 = \frac{(C_{z2} + C_M)C_P}{(C_{z2} + C_M) + C_P} + C_T \dots\dots\dots(2)$$

$$C_3 = \frac{(C_{z3} + C_M)C_P}{(C_{z3} + C_M) + C_P} + C_T \dots\dots\dots(3)$$

此外:

$$C_1 = \frac{f_{z3}^2}{f_{z1}^2} C_3 \stackrel{\text{令}}{=} k_{z31}^2 C_3 \dots\dots\dots(4)$$

$$C_2 = \frac{f_{z3}^2}{f_{z2}^2} C_3 \stackrel{\text{令}}{=} k_{z32}^2 \dots\dots\dots(5)$$

由(1)−(2)=(4)−(5), 并令 $H = C_M + C_P$, 有:

$$\frac{(C_{z1} - C_{z2})(H - C_M)C_P}{(C_{z1} + H)(C_{z2} + H)} = (k_{z31}^2 - k_{z32}^2)C_3 \dots\dots\dots(6)$$

由(1)−(3)=(4)− C_3 , 同理, 得

$$\frac{(C_{z1}-C_{z3})(H-C_M)C_P}{(C_{z1}+H)(C_{z3}+H)} = (k_{z31}^2-1)C_3 \dots\dots\dots(7)$$

引进常数符号:

$$A = \frac{k_{z31}^2-1}{k_{z31}^2-k_{z32}^2} \dots\dots\dots(8)$$

$$B = \frac{C_{z1}-C_{z3}}{C_{z1}-C_{z2}} \dots\dots\dots(9)$$

由(7)/(6)便可得

$$H = \frac{BC_{z2}-AC_{z3}}{A-B} \dots\dots\dots(10)$$

$$\text{于是 } C_P = H - C_M \dots\dots\dots(11)$$

讨论四种特殊情形:

(1) 假定忽略布线电容, 即令 $C_M=0$, 则

$$C_P = H.$$

引进常数符号:

$$a = \frac{C_{z1}C_P}{C_{z1}+C_P}, \dots\dots\dots(12)$$

$$b = \frac{C_{z3}C_P}{C_{z3}+C_P}, \dots\dots\dots(13)$$

$$\text{由 } \frac{(1)}{(2)} = \frac{C_1}{C_2} = k_{z31}^2$$

$$\text{便可得 } C_T = \frac{a-bk_{z31}^2}{k_{z31}^2-1} \dots\dots\dots(14)$$

$$\text{而 } L_z = \frac{25330}{f_{z3}^2(b+G)} \dots\dots\dots(15)$$

(2) 假定忽略线圈自身电容, 即令 $C_T=0$ 。

引进常数符号:

$$h = \frac{C_{z1}+H}{C_{z3}+H} \dots\dots\dots(16)$$

参考(1)方法, 便可得:

$$C_M = \frac{C_{z1}-k_{z31}^2hC_{z3}}{k_{z31}^2h-1} \dots\dots\dots(17)$$

$$C_P = H - C_M; \dots\dots\dots$$

$$LZ = \frac{25330}{f_{Z3}^2 C_3}.$$

式中

$$C_3 = \frac{(C_{Z3} + C_M)C_P}{C_{Z3} + H}.$$

(3) $C_M \neq 0$, 但已知 (分布电容的估计值, 约15Pf左右)。
引进常数符号:

$$m = \frac{(C_{Z1} + C_M)C_P}{C_{Z1} + H} \dots\dots\dots(18)$$

$$n = \frac{(C_{Z1} + C_M)C_P}{C_{Z1} + H} \dots\dots\dots(19)$$

参考 (1) 方法, 即可得:

$$C_T = \frac{m - nk_{Z31}^2}{k_{Z31}^2 - 1} \dots\dots\dots(20)$$

$$LZ = \frac{25330}{f_{Z3}^2 (n + C_T)}.$$

(4) $C_T \neq 0$ 但已知 (即线圈自身电容的估计值)。
这时计算比较复杂。由 (1)、(3) 及 (4) 式可以解得:
其中 $C_M = F - R \dots\dots\dots(21)$

$$R = \sqrt{F^2 - G} \dots\dots\dots(22)$$

$$F = \frac{C_{Z1} + r_H - H - C_{Z3} r}{2(k_{Z31}^2 - 1)} \dots\dots\dots(23)$$

$$G = \frac{C_{Z1}H - C_{Z3}r_H - S}{k_{Z31}^2 - 1} \dots\dots\dots(24)$$

$$S = g r - P, \dots\dots\dots(25)$$

$$r = k_{Z31}^2 \frac{C_{Z1} + H}{C_{Z3} + H}, \dots\dots\dots(26)$$

$$P = C_T (C_{Z1} + H), \dots\dots\dots(27)$$

$$g = C_T (C_{Z3} + H), \dots\dots\dots(28)$$

$$C_P = H - C_M.$$

$$LZ = \frac{25330}{f_{Z3}^2 C_3};$$

式中,

$$C_3 = \frac{(C_{Z3} + C_M)C_P}{C_{Z3} + H} + C_T.$$

3. 具体计算:

(1) 401的计算:

取 $f_{\min} = 520\text{KC}$;

$f_{\max} = 1650\text{KC}$;

已知: $C_{R\min} = 12\text{Pf}$,

$C_{R\max} = 365\text{Pf}$.

因此: $k^2 = \frac{f_{\max}^2}{f_{\min}^2} = \frac{1650^2}{520^2} = 10.05$.

$$C_L = \frac{C_{R\max} - k^2 C_{R\min}}{k^2 - 1} = \frac{365 - 10.05 \times 12}{10.05 - 1} = 27\text{Pf};$$

$$L_R = \frac{25330}{f_{\min}^2 (C_{R\max} + C_L)} = \frac{25330}{(0.52)^2 \times (365 + 27)} = 239\mu\text{h}; \quad (\text{实测 } 238\mu\text{h})$$

取三点统调频率为 $f_1 = 600\text{KC}$, $f_2 = 1000\text{KC}$, $f_3 = 1500\text{KC}$, 则有:

$$C_{R1} = \frac{25330}{f_1^2 L_R} - C_L = \frac{25330}{0.6^2 \times 239} - 27 = 267\text{Pf};$$

$$C_{R2} = \frac{25330}{f_2^2 L_R} - C_L = \frac{25330}{1^2 \times 239} - 27 = 79\text{Pf};$$

$$C_{R3} = \frac{25330}{f_3^2 L_R} - C_L = \frac{25330}{1.5^2 \times 239} - 27 = 20\text{Pf};$$

因为所用双连为等容的, 故

$$C_{Z1} = C_{R1}, \quad C_{Z2} = C_{R2}, \quad C_{Z3} = C_{R3}.$$

计算几个常数:

$$k_{Z31}^2 = \frac{f_{Z3}^2}{f_{Z1}^2} = \frac{(1.500 + 0.465)^2}{(0.600 + 0.465)^2} = 3.4;$$

$$k_{Z32}^2 = \frac{f_{Z3}^2}{f_{Z2}^2} = \frac{(1.500 + 0.465)^2}{(1.000 + 0.465)^2} = 1.8;$$

$$A = \frac{k_{z31}^2 - 1}{k_{z31}^2 - k_{z32}^2} = \frac{3.4 - 1}{3.4 - 1.8} = 1.5;$$

$$B = \frac{C_{z1} - C_{z3}}{C_{z1} - C_{z2}} = \frac{267 - 20}{267 - 78} = 1.314;$$

$$\text{于是, } H = \frac{BC_{z2} - AC_{z3}}{A - B} = \frac{1.314 \times 79 - 1.5 \times 20}{1.5 - 1.314} = 396 \text{Pf.}$$

四种特殊振荡回路的具体计算如下:

(1) $C_M = 0$, 则

$$C_P = H = 396 \text{Pf}$$

$$a = \frac{C_{z1} C_P}{C_{z1} + C_P} = \frac{267 \times 396}{267 + 396} = 160;$$

$$b = \frac{C_{z3} C_P}{C_{z3} + C_P} = \frac{20 \times 396}{20 + 396} = 19;$$

$$C_T = \frac{a - b k_{z31}^2}{k_{z31}^2 - 1} = \frac{160 - 19 \times 3.4}{3.4 - 1} = 39.4 \text{Pf};$$

$$L_Z = \frac{25330}{f_{z3}^2 (b + C_T)} = \frac{25330}{1.995^2 \times (19 + 39.7)} = 112 \mu\text{h.}$$

(2) $C_T = 0$, 则:

$$h = \frac{C_{z1} + H}{C_{z3} + H} = \frac{267 + 396}{20 + 396} = 1.59$$

$$C_M = \frac{C_{z1} - k_{z31}^2 h C_{z3}}{k_{z31}^2 h - 1} = \frac{267 - 3.4 \times 1.9 \times 20}{3.4 \times 1.59 - 1} = 36.1 \text{Pf};$$

$$C_P = H - C_M = 396 - 36.1 = 360 \text{Pf};$$

$$C_3 = \frac{(C_{z3} + C_M) C_P}{(C_{z3} + H)} = \frac{(20 + 36.1) \times 360}{20 + 396} = 48.4 \text{Pf};$$

$$L_Z = \frac{25330}{f_{z3}^2 C_3} = \frac{25330}{1.965^2 \times 48.4} = 135 \mu\text{h.}$$

由以上二种特殊振荡回路计算可以看出, 若二种情形的频率范围一样, 要保证二者都三点统调, 第(2)种情形所用的垫整电容器必须比第(1)种情形的小; 换句话说, 若第(2)种情形要与第(1)种情形用同样的垫整电容, 为了仍然保证三点统调, 则第(2)种情形的频率范围要比第(1)种情形的窄, 否则1000KC将铜失谐。

(3) $C_M \neq 0$, 假定 $C_M = 15 \text{Pf}$, 则

$$C_P = H - C_M = 396 - 15 = 381 \text{Pf}。 \text{ (实际用390Pf)}$$

$$m = \frac{(C_{z1} + C_M)C_P}{C_{z1} + H} = \frac{(267 + 15) \times 381}{276 + 396} = 162;$$

$$n = \frac{(C_{z3} + C_M)C_P}{C_{z3} + H} = \frac{(20 + 15) \times 381}{20 + 396} = 32.1;$$

$$C_T = \frac{m - nk_{z31}^2}{k_{z31}^2 - 1} = \frac{162 - 32.1 \times 3.4}{3.4 - 1} = 22.1 \text{Pf};$$

$$L_Z = \frac{25330}{f_{z3}^2(n + C_T)} = \frac{25330}{1.965^2 \times (32.1 + 22.1)} = 122 \mu\text{h}; \quad \text{(实测} 123.5 \mu\text{h)}$$

(4) $C_T \neq 0$, 假定 $C_T = 8 \text{Pf}$, 则:

$$P = C_T(C_{z1} + H) = 8 \times (267 + 396) = 5304;$$

$$g = C_T(C_{z3} + H) = 8 \times (20 + 396) = 3328;$$

$$r = \frac{k_{z31}^2(C_{z1} + H)}{C_{z3} + H} = \frac{3.4 \times (267 + 396)}{267 + 396} = 5.4;$$

$$S = gr - P = 3328 \times 5.4 - 5304 = 12676;$$

$$G = \frac{C_{z1}H - C_{z3}rH - S}{k_{z31}^2 - 1} = \frac{267 \times 396 - 20 \times 5.4 \times 396 - 12676}{3.4 - 1} = 20880;$$

$$F = \frac{C_{z1} + rH - H - C_{z3}r}{2(k_{z31}^2 - 1)} = \frac{267 + 5.4 \times 396 - 396 - 20 \times 5.4}{2 \times (3.4 - 1)} = 396;$$

$$C_M = F - \sqrt{F^2 - G} = 396 - \sqrt{396^2 - 20880} = 29 \text{Pf};$$

$$C_P = H - C_M = 396 - 29 = 367 \text{Pf};$$

$$C_3 = \frac{(C_{z3} + C_M)C_P}{C_{z3} + H} + C_T = \frac{(20 + 29) \times 367}{20 + 396} = 51.2 \text{Pf};$$

$$L_Z = \frac{25330}{f_{z3}^2 C_3} = \frac{25330}{1.965^2 \times 51.2} = 128 \mu\text{h}。$$

(2) 402短波的计算(倍频):

$$\text{取 } f_{\min} = 3.8 \text{MC}, \quad f_{\max} = 12.4 \text{MC},$$

$$\text{则 } k^2 = \frac{f_{\max}^2}{f_{\min}^2} = \left(\frac{12.4}{3.8}\right)^2 = 10.63;$$

$$C_L = \frac{C_{R\max} - k^2 C_{R\min}}{k^2 - 1} = \frac{365 - 10.63 \times 12}{10.67 - 1} = 24.65 \text{Pf};$$

$$L_R = \frac{25330}{f_{\min}^2(C_{R\max} + C_L)} = \frac{25330}{3.8^2 \times (365 + 24.65)} = 4.50 \mu\text{h} \text{ (实测} 4.48 \mu\text{h)};$$