Annex to the paper

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Solving NLS Equation for a Nonlinear Media using Volterra series

Volterra series expansion is one of the most powerful methods for describing the non-linear systems. We will now obtain the output of the nonlinear system by solving NLS equations with Volterra series. If we consider the first 3 terms of the Volterra series we will have a good approximation of the solution of NLS equation. So $X_o(\omega, z)$ can be evaluated as:

$$X_o(\omega, z) = X_{o_1}(\omega, z) + X_{o_2}(\omega, z) + X_{o_3}(\omega, z)$$

Where $X_{o_1}(\omega, z), X_{o_2}(\omega, z)\ and\ X_{o_3}(\omega, z)$are defined as follows

$$X_{o_1}(\omega, z) = \iint H'_{o_{1,2}}(\omega_1, \omega_2, \omega - \omega_1 + \omega_2, z) \times C(\omega_1) S^*(\omega_2) C(\omega - \omega_1 + \omega_2) d\omega_1 d\omega_2$$

$$X_{o_2}(\omega, z) = \iint \iint H'_{o_{3,2}}(\omega_1, \omega_2, \omega_3, \omega_4, \omega - \omega_1 + \cdots + \omega_4, z) \times C(\omega_1) S^*(\omega_2) S(\omega_3) S^*(\omega_4)$$

$$\times C(\omega - \omega_1 + \cdots + \omega_4) d\omega_1 \dots d\omega_4$$

$$X_{o_3}(\omega, z) = \iint \iint H'_{o_{1,4}}(\omega_1, \omega_2, \omega_3, \omega_4, \omega - \omega_1 + \cdots + \omega_4, z) \times C(\omega_1) C^*(\omega_2) C(\omega_3) S^*(\omega_4)$$

$$\times C(\omega - \omega_1 + \cdots + \omega_4) d\omega_1 \dots d\omega_4$$

Where c(t), s(t) are the clock and the received signal in time domain, $C(\omega), S(\omega)$ are the Fourier transform of the clock and received signal and the Volterra kernels, $H'_{o_{1,2}}, H'_{o_{3,2}}\ and\ H'_{o_{1,4}}$ are calculated as follows

$$H'_{o_{1,2}}(\omega_1, \omega_2, \omega - \omega_1 + \omega_2, z) = 2j\gamma_{OSC} e^{G_1(\omega)z} \left(\frac{1 - e^{-2\alpha z}}{2\alpha}\right)$$

$$H'_{o_{3,2}}(\omega_1, \omega_2, \omega_3, \omega_4, \omega - \omega_1 + \cdots + \omega_4, z) = 2\gamma_{OSC}(\gamma_{SS} + 2\gamma_{OS}) e^{G_1(\omega)z} \left(\frac{1 - e^{-2\alpha z}}{2\alpha}\right)^2$$

$$H'_{o_{1,4}}(\omega_1, \omega_2, \omega_3, \omega_4, \omega - \omega_1 + \cdots + \omega_4, z) = 8\gamma_{OSC}(\gamma_{SC} + 2\gamma_{OC}) e^{G_1(\omega)z} \left(\frac{1 - e^{-2\alpha z}}{2\alpha}\right)^2$$

Where α is the linear attenuation constant, γ_{ijkl} is spatial distribution of the fiber mode. For simplicity of calculation we suppose that the received and the clock signals are Sinc shape. So these signals in time and spectral domain as follow:

$$c(t) = \sum_{m=1}^{k} A_c'.\mathrm{Sinc}\left(\frac{t-(C_m.{}^{T_b}/_F)}{T_c}\right)$$

$$C(\omega) = F\{c(t)\} = A_c'.T_c.\pi.rect(\frac{\omega.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.({}^{T_b}/_F).\omega}$$

$$s(t) = b.\sum_{m=1}^{k} A_d.\mathrm{Sinc}\left(\frac{t-(C_m.{}^{T_b}/_F)}{T_d}\right)$$

$$S(\omega) = F\{s(t)\} = b.A_d.T_d\pi.rect(\frac{\omega.T_d}{2}).\sum_{m=1}^{k} e^{-2\pi j C_m.({}^{T_b}/_F).\omega}$$

Where A_c', A_d are amplitudes of the clock and the received signals, C_m is the code's number, k is the weight of the code, T_d, T_c are full width at half maximum (FWHM) of the data pulse and the clock pulse-width (code word) , T_b is duration of bit and b is bit value can be "0', "1'. So we can write the first three output response terms as follow:

$$X_{o_1}(\omega,z) = \iint 2j\gamma_{OSC}e^{G_1(\omega)z}\left(\frac{1-e^{-2\alpha z}}{2\alpha}\right) \times \{A_c'.T_c.\pi.rect(\frac{\omega_1.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.({}^{T_b}/_F).\omega_1}\}.$$

$$\times\left\{b.A_d.T_d\pi.rect\left(\frac{\omega_2.T_d}{2}\right).\sum_{m=1}^{k} e^{2\pi j C_m.({}^{T_b}/_F).\omega_2}\right\}.$$

$$\times \{A_c'.T_c.\pi.rect(\frac{(\omega-\omega_1+\omega_2).T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.({}^{T_b}/_F).(\omega-\omega_1+\omega_2)}\}d\omega_1 d\omega_2$$

$$X_{o_2}(\omega,z) = \iint\iint 2\gamma_{OSC}(\gamma_{SS}+2\gamma_{OS})e^{G_1(\omega)z}\left(\frac{1-e^{-2\alpha z}}{2\alpha}\right)^2$$

$$\times \{A_c'.T_c.\pi.rect(\frac{\omega_1.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.({}^{T_b}/_F).\omega_1}\}.$$

$$\times\left\{b.A_d.T_d\pi.rect(\frac{\omega_2.T_d}{2}).\sum_{m=1}^{k} e^{2\pi j C_m.({}^{T_b}/_F).\omega_2}\right\}$$

$$\times\left\{A_c'.T_c.\pi.rect(\frac{\omega_3.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.({}^{T_b}/_F).\omega_3}\right\}$$

$$\times\left\{b.A_d.T_d\pi.rect(\frac{\omega_4.T_d}{2}).\sum_{m=1}^{k} e^{2\pi j C_m.({}^{T_b}/_F).\omega_4}\right\}$$

$$\times \{A_c'.T_c.\pi.rect(\frac{(\omega-\omega_1+\cdots+\omega_4).T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.(^{T_b}/_F).(\omega-\omega_1+\cdots+\omega_4)}\} \times d\omega_1 \dots d\omega_4$$

$$X_{o_3}(\omega,z) = \iint\iint 8\gamma_{OSC}(\gamma_{SC}+2\gamma_{OC})e^{G_1(\omega)z}(\frac{1-e^{-2\alpha z}}{2\alpha})^2$$

$$\times \{A_c'.T_c.\pi.rect(\frac{\omega_1.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.(^{T_b}/_F).\omega_1}\}.$$

$$\times \left\{A_c'.T_c.\pi.rect(\frac{\omega_2.T_c}{2}).\sum_{m=1}^{K} e^{2\pi j C_m.(^{T_b}/_F).\omega_2}\right\}$$

$$\times \left\{A_c'.T_c.\pi.rect(\frac{\omega_3.T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.(^{T_b}/_F).\omega_3}\right\}$$

$$\times \left\{b.A_d.T_d\pi.rect(\frac{\omega_4.T_d}{2}).\sum_{m=1}^{k} e^{2\pi j C_m.(^{T_b}/_F).\omega_4}\right\}$$

$$\times \{A_c'.T_c.\pi.rect(\frac{(\omega-\omega_1+\cdots+\omega_4).T_c}{2}).\sum_{m=1}^{K} e^{-2\pi j C_m.(^{T_b}/_F).(\omega-\omega_1+\cdots+\omega_4)}\} \times d\omega_1 \dots d\omega_4$$

By calculating the integration in (), (), () and depending on whether T_c is larger than T_d or not, we obtain different responses in different frequency ranges. By defining f(x) and E_1 as:

$$f(x) = \frac{1}{2\pi j(^{T_b}/_F)}\, e^{-2\pi j(^{T_b}/_F).x}$$

$$, E_1 = 2\pi^3 bj\gamma_{OSC}e^{G_1(\omega)z}\left(\frac{1-e^{-2\alpha z}}{2\alpha}\right)A_d{A_c'}^2T_dT_c^2$$

Then, for $T_d > T_c$, X_{o_1} would be:

(1) For $\omega > \frac{2}{T_c}+\frac{1}{T_d}$ $\rightarrow$ $X_{o_1}(\omega,z)=0$

(2) For $\frac{1}{T_d} < \omega < \frac{2}{T_c}+\frac{1}{T_d}$

$$X_{o_1}(\omega,z) = E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{1}{(C_l-C_m)}.\frac{2\pi j(^{T_b}/_F)}{(C_i+C_m-2C_l)}f\left((C_l-C_i)\frac{2}{T_c}\right).f\left((C_i-C_m-2C_l)\left(\frac{1}{T_d}\right)\right).f(C_i(\omega))$$

(3) For $\frac{-2}{T_c}+\frac{1}{T_d} < \omega < \frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{2\pi j(^{T_b}/_{F})}{(C_l-C_m).}\cdot\{\frac{1}{(C_i-C_m)}f(C_i\omega)f((C_m-C_l)\left(\frac{2}{T_c}\right))\ .f((C_m-C_i)\left(\frac{1}{T_d}\right))$$

$$+\frac{1}{(C_i+C_m-2C_l)}f((2C_l-C_i)\omega)f((C_m-C_l)\left(\frac{2}{T_c}\right))f((C_i+C_m-2C_l)(\frac{1}{T_d}))\}$$

(4) For $\frac{-2}{T_c}-\frac{1}{T_d}<\omega<\frac{-2}{T_c}+\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{2\pi j\left(^{T_b}/_{F}\right)}{(C_m-C_l)}\frac{1}{(C_i-C_m)}f\left((2C_m-C_i)\omega\right)f((2C_m-C_l-C_i)\left(\frac{2}{T_c}\right))f((C_i-C_m)(\frac{1}{T_d}))$$

(5) For $\omega<\frac{-2}{T_c}-\frac{1}{T_d}$ → $X_{o_1}(\omega,z)=0$

When the pulse-width of the data is smaller than the pulse-width of clock ($T_d<T_c$) we have:

(1) For $\omega>\frac{2}{T_c}+\frac{1}{T_d}$ → $X_{o_1}(\omega,z)=0$

(2) For $\frac{1}{T_d}<\omega<\frac{2}{T_c}+\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\ \frac{1}{(C_l-C_m)}\cdot\frac{2\pi j\left(^{T_b}/_{F}\right)}{(C_i+C_m-2C_l)}f((C_l-C_i)\frac{2}{T_c})f((C_i-C_m-2C_l)\left(\frac{1}{T_d}\right))f(C_i(\omega))$$

(3) For $\frac{2}{T_c}-\frac{1}{T_d}<\omega<\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{1}{(C_l-C_m)}\{\frac{2\pi j\left(^{T_b}/_{F}\right)}{(C_i-C_m)}f(C_i(\omega))f((C_m-C_l)\left(\frac{2}{T_c}\right))f((C_i-C_m)\left(\frac{1}{T_d}\right))$$

$$+\frac{1}{(C_i+C_m-2C_l)}f\left((C_m-2C_l)(\omega)\right)f((C_l-C_i)\left(\frac{2}{T_c}\right))$$

(4) For $\frac{-2}{T_c}+\frac{1}{T_d}<\omega<\frac{2}{T_c}-\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{2\pi j(^{T_b}/_{F})}{(C_l-C_m)}\cdot\{\frac{1}{(C_i-C_m)}f(C_i(\omega))f((C_m-C_l)\left(\frac{2}{T_c}\right))f((C_i-C_m)\left(\frac{1}{T_d}\right))$$

$$+\frac{1}{(C_i+C_m-2C_l)}f((2C_l-C_i)(\omega))f((C_m-C_l)\left(\frac{2}{T_c}\right))f((C_i+C_m-2C_l)(\frac{1}{T_d}))\}$$

(5) For $-\frac{1}{T_d}<\omega<\frac{-2}{T_c}+\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{1}{(C_l-C_m)}.\{\frac{1}{(C_i-C_m)}f(C_m(\omega))f((C_l+C_i-2C_m)\left(\frac{2}{T_c}\right))$$

$$+\frac{2\pi j\left(T_b/_F\right)}{(C_i+C_m-2C_l)}f((2C_l-C_i)(\omega))f((C_m-C_l)\left(\frac{2}{T_c}\right))f((C_i+C_m-2C_l)(\frac{1}{T_d}))\}$$

(6) For $\frac{-2}{T_c}-\frac{1}{T_d}<\omega<-\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=E_1\sum_{m=1}^{K}\sum_{i=1}^{K}\sum_{l=1}^{K}\frac{2\pi j\left(T_b/_F\right)}{(C_l-C_m)}\frac{1}{(C_i-C_m)}f\left((2C_m-C_i)(\omega)\right)f((2C_m-C_l-C_i)\left(\frac{2}{T_c}\right))f((C_m-C_i)(\frac{1}{T_d}))$$

(7) For $\omega<\frac{-2}{T_c}-\frac{1}{T_d}$

$$X_{o_1}(\omega,z)=0$$

For calculating the $X_{o_2}(\omega,z)$ and by defining S, S_1,S_2,S_3,S_4 and E_2 as:

$$E_2=2\pi^5{A'_c}^3T_c^3b^2A_d^2T_d^2\gamma_{OSC}(\gamma_{SS}+2\gamma_{OS})e^{G_1(\omega)z}\left(\frac{1-e^{-2\alpha z}}{2\alpha}\right)^2$$

$$,S=\frac{1}{2\pi j(C_m-C_l).\left(T_b/_F\right)}$$

$$,S_1=\frac{1}{-2\pi j(C_p-C_m).\left(T_b/_F\right)}$$

$$,S_2=\frac{1}{-2\pi j(C_p+C_m-2C_l).\left(T_b/_F\right)}$$

$$,S_3=\frac{1}{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right)}$$

$$,S_4=\frac{1}{2\pi j(C_n-C_p).\left(T_b/_F\right)}$$

Then, for $T_d>T_c$, X_{o_2}would be:

(1) $\omega>\frac{3}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=0$$

(2) $\frac{3}{T_c}<\omega<\frac{3}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}S.S_1.S_3.\frac{1}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(3C_i-2C_l-C_m).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_i-C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$. e^{-2\pi j C_i.\left(T_b/F\right).\omega}$$

(3) $\frac{1}{T_c}+\frac{2}{T_d}<\omega<\frac{3}{T_c}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} S.S_1.S_3.\{\frac{1}{2\pi j\left(C_i+C_p-2C_m\right).\left(T_b/F\right)}e^{2\pi j(3C_i-2C_l-C_m).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(C_i+C_n+2C_p-2C_m\right).\left(T_b/F\right).\left(\frac{2}{T_d}\right)}.$$

$$e^{-2\pi j C_i.\left(T_b/F\right).\omega}+\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(-3C_i+6C_n-2C_l-C_m).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i-C_n+C_p-2C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i-2C_n).\left(T_b/F\right).\omega}$$

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(4) $\frac{3}{T_c}+\frac{2}{T_d}<\omega<\frac{1}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} S.S_2.S_4.\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(C_i-C_m).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i-C_n+C_p\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j C_i.\left(T_b/F\right).\omega}$$

$$+S.S_1.S_3.\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(C_i+C_m-2C_l).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i+C_p-C_n-2C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/F\right)(\omega)}$$

$$S.S_1.S_3.\frac{1}{2\pi j\left(C_i-C_n+2C_p-4C_m\right).\left(T_b/F\right)}e^{2\pi j(C_i+3C_m-2C_l-2C_p).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i+5C_p+3C_n-10C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/F\right)(\omega)}$$

$$+S.S_1.S_3.\frac{1}{2\pi j\left(C_n+C_p-2C_m\right).\left(T_b/F\right)}e^{2\pi j(C_m-C_p+2C_i-2C_l).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_i).\left(T_b/F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi j(C_p-2C_m).\left(T_b/F\right)(\omega)}$$

$$+S.S_1.S_3.\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(6C_n-2C_l-C_m-3C_i).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i-C_n+C_p-2C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i-2C_n).\left(T_b/F\right)(\omega)}$$

(5) $\frac{1}{T_c}<\omega<\frac{3}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} S.S_2.S_4.\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(C_i-C_m).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i-C_n+C_p\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j C_i.\left(T_b/F\right).\omega}$$

$$+S.S_1.S_3.\frac{1}{2\pi j(C_i-C_n).\left(T_b/F\right)}e^{2\pi j(C_i+C_m-2C_l).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i+C_p-C_n-2C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/F\right)(\omega)}$$

$$S.S_1.S_3.\frac{1}{2\pi j\left(C_i-C_n+2C_p-4C_m\right).\left(T_b/F\right)}e^{2\pi j(C_i+3C_m-2C_l-2C_p).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(2C_i+5C_p+3C_n-10C_m\right).\left(T_b/F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/F\right)(\omega)}$$

$$+S.S_1.S_3.\frac{1}{2\pi j\left(C_n+C_p-2C_m\right).\left(T_b/F\right)}e^{2\pi j(7C_m-4C_p-2C_l-C_i).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi j(2C_p-C_i-4C_m).\left(T_b/F\right)(\omega)}$$

(6) $\frac{-1}{T_c}+\frac{2}{T_d}<\omega<\frac{1}{T_c}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} S.S_2.S_4.\frac{1}{2\pi j(C_i-C_p).\left(T_b/F\right)}e^{2\pi j(C_i-C_m).\left(T_b/F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi j C_i.\left(T_b/F\right).\omega}$$

$$+S.S_1.S_3.\frac{1}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(C_m-2C_l+C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+S.S_2.S_4.\frac{1}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_p-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$

$$+S.S_1.S_3.\frac{1}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_i+C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+C_p-C_n-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$S.S_1.S_3.\frac{1}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(9C_m-C_i-C_n-2C_l-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+4C_p+2C_n-8C_m).\left(T_b/_F\right)(\omega)}$$

(7) $\frac{1}{T_c}-\frac{2}{T_d}<\omega<\frac{-1}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)$$

$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(2C_p-C_m-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$

$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_p-2C_l-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi jC_p.\left(T_b/_F\right).\omega}.e^{2\pi j(2C_i-C_m-C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_i).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{-2\pi j(2C_m-C_p).\left(T_b/_F\right)(\omega)}.e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p+2C_m-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_n-C_m-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$

$$\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}.e^{2\pi j(C_m+2C_n-2C_l-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+C_p-C_n-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right).\omega}.e^{2\pi j(11C_m-6C_p-2C_l-2C_n-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(8) $\frac{-3}{T_c}+\frac{2}{T_d}<\omega<\frac{-1}{T_c}$

$$X_{o_2}(\omega,z)$$

$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(2C_p-C_m-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$

$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_p-2C_l-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(C_i-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j2C_n-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{-2\pi j(C_i+2C_p-2C_m).\left(T_b/_F\right)(\omega)}.e^{2\pi j(C_m+C_i-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_n+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(9) $-\frac{3}{T_c}+\frac{2}{T_d}<\omega<-\frac{1}{T_c}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-2C_p-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_n-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(2C_n-C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p+C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{-2\pi j(2C_n-4C_p+C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_n-2C_p-C_m+C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(8C_m-4C_p-2C_n-C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_p+2C_n+C_i-3C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(10) $\frac{-1}{T_c}-\frac{2}{T_d}<\omega<\frac{-3}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j\left(C_n+C_i-2C_p\right).\left(T_b/_F\right)}e^{-2\pi j(C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.$$

$$e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{-2\pi jC_p.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-5C_p+2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_n-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(2C_n-C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p+C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n-4C_p+C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_n-2C_p-C_m+C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(8C_m-4C_p-2C_n-C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_p+2C_n+C_i-3C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(11) $\frac{-3}{T_c}<\omega<\frac{-1}{T_c}-\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j\left(C_n+C_i-2C_p\right).\left(T_b/_F\right)}e^{-2\pi j(C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.$$

$$e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{-2\pi j(C_i-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-6C_p+3C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_n-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(12) $\frac{-3}{T_c}-\frac{2}{T_d}<\omega<\frac{-3}{T_c}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j\left(C_n+C_i-2C_p\right).\left(T_b/_F\right)}e^{-2\pi j(C_i+2C_n-4C_p).\left(T_b/_F\right).\omega}.e^{2\pi j\left(5C_m+6C_n+3C_i-2C_l-12C_p\right).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.$$

$$e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(13) $\omega < \frac{-3}{T_c} - \frac{2}{T_d}$

$$X_{o_2}(\omega, z) = 0$$

When the pulse-width of the data is smaller than the pulse-width of clock ($T_d < T_c$) for X_{o_2} we have:

(1) $\omega > \frac{3}{T_c} + \frac{2}{T_d}$

$$X_{o_2}(\omega, z) = 0$$

(2) $\frac{3}{T_c} < \omega < \frac{3}{T_c} + \frac{2}{T_d}$

$$X_{o_2}(\omega, z) = E_2 \sum_{m=1}^{k} \sum_{n=1}^{k} \sum_{p=1}^{k} \sum_{i=1}^{k} \sum_{l=}^{k} S.S_1.S_3. \frac{1}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(3C_i - 2C_l - C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(2C_i - C_n + C_p - 2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} .. e^{-2\pi j C_i.\left(T_b/_F\right).\omega}$$

(3) $\frac{3}{T_c} < \omega < \frac{1}{T_c} + \frac{2}{T_d}$

$$X_{o_2}(\omega, z) = E_2 \sum_{m=1}^{k} \sum_{n=1}^{k} \sum_{p=1}^{k} \sum_{i=1}^{k} \sum_{l=}^{k} \frac{S.S_2.S_4}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(C_i - C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(2C_i - C_p - C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j C_i.\left(T_b/_F\right).\omega}$$

$$+ \frac{S.S_1.S_3}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(C_i + C_m - 2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(2C_i + C_p - C_n - 2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j C_i.\left(T_b/_F\right)(\omega)} .$$

$$+ \frac{S.S_1.S_3}{2\pi j(C_i + C_p - 2C_m).\left(T_b/_F\right)} e^{2\pi j(2C_n + C_i - C_m - 2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(2C_i + 2C_p - 4C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)} . e^{-2\pi j C_i.\left(T_b/_F\right)(\omega)}$$

$$+ \frac{S.S_1.S_3}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(2C_i + C_n - C_m - 2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(C_p + C_n - 2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j C_i.\left(T_b/_F\right)(\omega)}$$

(4) $-\frac{1}{T_c} + \frac{2}{T_d} < \omega < \frac{3}{T_c}$

$$X_{o_2}(\omega, z) = E_2 \sum_{m=1}^{k} \sum_{n=1}^{k} \sum_{p=1}^{k} \sum_{i=1}^{k} \sum_{l=}^{k} \frac{S.S_2.S_4}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(3C_i - 2C_n - C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(C_n - C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j C_i.\left(T_b/_F\right).\omega}$$

$$+ \frac{S.S_1.S_3}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(3C_i - 2C_n + C_m - 2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(C_p + C_n - 2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j(C_i).\left(T_b/_F\right)(\omega)}$$

$$+ \frac{S.S_1.S_3}{2\pi j(C_i + C_n + 2C_p - 4C_m).\left(T_b/_F\right)} e^{2\pi j(3C_i + 2C_n - 5C_m - 2C_l + 2C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(C_p + C_n - 2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j(C_i).\left(T_b/_F\right)(\omega)}$$

$$+ \frac{S.S_2.S_4}{2\pi j(C_i - C_n).\left(T_b/_F\right)} e^{2\pi j(3C_n - 2C_i - C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)} . e^{2\pi j(2C_i - C_n - C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)} . e^{-2\pi j C_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(3C_n-2C_l+C_m-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(5C_m+2C_n-3C_p-2C_l-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_p-2C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_n-2C_l-C_m-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(2C_n-C_i).\left(T_b/_F\right)(\omega)}$$

(5) $\frac{1}{T_c}<\omega<\frac{-1}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-C_i-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_i-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(C_m+4C_n-2C_l-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(11C_m-C_i-2C_l-6C_p-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_i).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-3C_n-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(3C_n-2C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-3C_n+C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(3C_n-2C_i+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(4C_i+4C_p+3C_n-9C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(6C_m-2C_i-3C_p-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(3C_n-2C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(3C_n+C_m-2C_i-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-2C_l+5C_m-2C_i-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_p-2C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_n-2C_l-C_m-C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(2C_n-C_i).\left(T_b/_F\right)(\omega)}$$

(6) $\frac{3}{T_c}-\frac{2}{T_d}<\omega<\frac{1}{T_c}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_m-2C_p+C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3.}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(C_i+2C_n-3C_m-2C_l+2C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_p+C_n-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m+C_n-2C_i-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+3C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-2C_i-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi j(C_p).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(3C_m+2C_n-C_p-2C_l-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right).}e^{2\pi j(C_p-2C_m).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(15C_m-2C_i-2C_l-8C_p-3C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-3C_n-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(3C_n-2C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-3C_n+C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(3C_n-2C_i+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi j(C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(4C_i+4C_p+3C_n-9C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(6C_m-2C_i-3C_p-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_n-3C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_n+C_m-3C_i-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-2C_l+7C_m-3C_i-4C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

(7) $\quad \frac{-3}{T_c}+\frac{2}{T_d}<\omega<\frac{3}{T_c}-\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_m-2C_p+C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{2}{T_d}\right).}e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3.}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(C_i+2C_n-3C_m-2C_l+2C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_p+C_n-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m+C_n-2C_i-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+3C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-2C_i-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi j(C_p).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(3C_m+2C_n-C_p-2C_l-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right).}e^{2\pi j(C_p-2C_m).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(15C_m-2C_i-2C_l-8C_p-3C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i+C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(C_i-2C_p+3C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right)(\omega)}$$

(8) $\frac{-1}{T_c}<\omega<\frac{-3}{T_c}+\frac{2}{T_d}$

$$X_{o_2}(\omega,z)$$

$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-8C_p-3C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(6C_p-C_m-3C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$

$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(C_i).\left(T_b/_F\right).\omega}.e^{2\pi j(13C_m-2C_n-6C_p-2C_l-3C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n+5C_p-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-5C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(3C_n-2C_i-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(5C_n-C_m-8C_p+4C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(3C_p-2C_i-C_n).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{2\pi j(C_n-2C_p).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3.}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(4C_i+5C_n-15C_m-2C_l+8C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(6C_m-3C_p-C_n-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m+C_n-2C_i-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-2C_i-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_p).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(3C_m+2C_n-C_p-2C_l-2C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{2\pi j(C_p-2C_m).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(15C_m-2C_i-2C_l-8C_p-3C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(C_i+C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(C_i-2C_p+3C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+C_p-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right)(\omega)}$$

(9) $\frac{1}{T_c}-\frac{2}{T_d}<\omega<-\frac{1}{T_c}$

$$X_{o_2}(\omega,z)$$
$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-4C_p-C_i+2C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{-2\pi jC_p.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p-2C_i+2C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_p-2C_i).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{-2\pi j(C_n-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(4C_p-C_m-2C_i-C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(3C_p-2C_i-C_n).\left(T_b/_F\right).(\frac{1}{T_d})}+$$
$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{-2\pi j(2C_p+C_n-4C_m).\left(T_b/_F\right).\omega}.e^{2\pi j(9C_m-C_n-4C_p-2C_l-2C_i).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(6C_m-2C_i-C_n-3C_p).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i-5C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(3C_n-2C_i-C_p).\left(T_b/_F\right).(\frac{1}{T_d})}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(5C_n-C_m-8C_p+4C_i).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(3C_p-2C_i-C_n).\left(T_b/_F\right).(\frac{2}{T_d})}.e^{2\pi j(C_n-2C_p).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3.}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(4C_i+5C_n-15C_m-2C_l+8C_p).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(6C_m-3C_p-C_n-2C_i).\left(T_b/_F\right).(\frac{1}{T_d})}.e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-C_i-2C_l-3C_p).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_i-C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\omega}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_i-2C_m).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).(\frac{1}{T_d})}.e^{2\pi j(C_i-2C_p).\left(T_b/_F\right)(\omega)}$$
$$+\frac{S.S_1.S_3}{2\pi j(C_i+C_p-2C_m).\left(T_b/_F\right)}e^{2\pi j(C_m+2C_n-2C_l-C_i).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_i+2C_p-4C_m).\left(T_b/_F\right).(\frac{2}{T_d})}.e^{2\pi j(C_i+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(11C_m-C_i-2C_l-6C_p-2C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_i+5C_p+3C_n-10C_m).\left(T_b/_F\right).(\frac{1}{T_d})}.e^{-2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right)(\omega)}$$

(10) $\frac{-3}{T_c}<\omega<\frac{1}{T_c}-\frac{2}{T_d}$

$$X_{o_2}(\omega,z)$$
$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\{\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-4C_p-C_i+2C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{-2\pi jC_p.\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-3C_p-2C_i+2C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(2C_p-2C_i).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{2\pi j(C_n-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(4C_p-C_m-2C_i-C_n).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(3C_p-2C_i-C_n).\left(T_b/_F\right).(\frac{1}{T_d})}+$$
$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_p+C_n-4C_m).\left(T_b/_F\right).\omega}.e^{2\pi j(9C_m-C_n-4C_p-2C_l-2C_i).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(6C_m-2C_i-C_n-3C_p).\left(T_b/_F\right).(\frac{1}{T_d})}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(3C_i-4C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).(\frac{1}{T_c})}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).(\frac{1}{T_d})}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(4C_n-C_m-2C_p+3C_i).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{2}{T_d}\right)}.e^{2\pi j(C_i+2C_n-4C_p).\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_1.S_3.}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(3C_i+4C_n+6C_p-11C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_p+C_n-2C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right)(\omega)}$$

(11) $\frac{-1}{T_c}-\frac{2}{T_d}<\omega<\frac{-3}{T_c}$

$$X_{o_2}(\omega,z)$$
$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(C_n-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-10C_p+2C_i+5C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n-C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$
$$\frac{S.S_1.S_4}{2\pi j(C_i-C_p).\left(T_b/_F\right)}e^{2\pi j(C_i-2C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-6C_p+C_i+2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_n+C_i-2C_p).\left(T_b/_F\right)}e^{2\pi j(C_i+2C_n-4C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(C_i-C_m-2C_p+2C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-5C_p+3C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}+$$
$$\frac{S.S_1.S_3}{2\pi j(2C_p+C_n+C_i-4C_m).\left(T_b/_F\right)}e^{2\pi j(4C_p+2C_n+C_i-8C_m).\left(T_b/_F\right).\omega}.e^{2\pi j(2C_n+2C_p-2C_l+C_i-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(3C_n+2C_i-10C_m+5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(12) $\frac{-3}{T_c}-\frac{2}{T_d}<\omega<\frac{-3}{T_c}$

$$X_{o_2}(\omega,z)$$
$$=E_2\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(C_i+2C_n-4C_p).\left(T_b/_F\right).\omega}.e^{2\pi j(5C_m-2C_l-12C_p+3C_i+6C_n).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i+3C_n-5C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}$$

(13) $\omega<\frac{-3}{T_c}-\frac{2}{T_d}$

$$X_{o_2}(\omega,z)=0$$

For calculating the $X_{o_3}(\omega,z)$ and by defining and E_3 as:

$$E_3=8\pi^5{A'_c}^4{T_c}^4bA_dT_d8\gamma_{ORC}(\gamma_{RC}+2\gamma_{OC})e^{G_1(\omega)z}(\frac{1-e^{-2\alpha z}}{2\alpha})^2$$

Then, for $T_d>T_c$, X_{o_2}would be:

(1) $\omega>\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=0$$

(2) $\frac{2}{T_c}+\frac{1}{T_d}<\omega<\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_i+C_p-2C_l-3C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}..e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

(3) $\frac{4}{T_c}-\frac{1}{T_d}<\omega<\frac{2}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+2C_n+C_p-3C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

(4 $\frac{1}{T_d}<\omega<\frac{4}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(6C_n-2C_i-3C_m-2C_l+C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(5) $\frac{2}{T_c}-\frac{1}{T_d}<\omega<\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(6C_n-2C_i-3C_m-2C_l+C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(6) $\frac{-2}{T_c}+\frac{1}{T_d}<\omega<\frac{2}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(7) $\frac{-1}{T_d}<\omega<\frac{-2}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)$$

$$=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(5C_m+2C_n-2C_l-2C_i-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j\left(C_i+C_n-2C_p\right).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_i+4C_n+3C_p-9C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(8) $\frac{-4}{T_c}+\frac{1}{T_d}<\omega<-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)$$
$$= E_3 \sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} \frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left({}^{T_b}/_{F}\right)} e^{2\pi j(5C_m+2C_n-2C_l-2C_i-3C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n-2C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left({}^{T_b}/_{F}\right).\omega}$$

$$+\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left({}^{T_b}/_{F}\right).\omega}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i+4C_n+3C_p-9C_m).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n+2C_p-4C_m).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left({}^{T_b}/_{F}\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i+C_p-C_m-2C_l).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left({}^{T_b}/_{F}\right)(\omega)}$$

(9) $\quad \frac{-2}{T_c}-\frac{1}{T_d}<\omega<-\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z) = E_3 \sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} \frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i+5C_m+6C_n-2C_l-11C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}..e^{2\pi j(C_n-2C_p).\left({}^{T_b}/_{F}\right).\omega}$$

$$+\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left({}^{T_b}/_{F}\right).\omega}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i+4C_n+3C_p-9C_m).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n+2C_p-4C_m).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left({}^{T_b}/_{F}\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right)} e^{2\pi j(2C_i+C_p-C_m-2C_l).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left({}^{T_b}/_{F}\right)(\omega)}$$

(10) $\quad \frac{-4}{T_c}-\frac{1}{T_d}<\omega<-\frac{2}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z) = E_3 \sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} \frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left({}^{T_b}/_{F}\right)} e^{2\pi j(4C_i+5C_m+8C_n-2C_l-15C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n-2C_p).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i+2C_n-4C_p).\left({}^{T_b}/_{F}\right).\omega}$$

(11) $\quad \omega<\frac{-4}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=0$$

When the pulse-width of the data is smaller than the pulse-width of clock ($T_d < T_c$) for X_{o_3} we have:

(1) $\quad \omega>\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=0$$

(2) $\quad \frac{4}{T_c}-\frac{1}{T_d}<\omega<\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z) = E_3 \sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k} \frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right)} e^{2\pi j(4C_i+C_p-2C_l-3C_m).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left({}^{T_b}/_{F}\right).\left(\frac{1}{T_d}\right)}..e^{-2\pi jC_i.\left({}^{T_b}/_{F}\right).\omega}$$

(3) $\frac{2}{T_c}+\frac{1}{T_d}<\omega<\frac{4}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(4C_n+C_p-2C_l-3C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}..e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

(4) $\frac{2}{T_c}-\frac{1}{T_d}<\omega<\frac{2}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(6C_n-2C_i-3C_m-2C_l+C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(5) $\frac{1}{T_d}<\omega<\frac{2}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

(6) $-\frac{1}{T_d}<\omega<\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}.$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{-2\pi jC_i.\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right)}.e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right)}.e^{2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$

$$\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(7) $\quad \frac{-2}{T_c}+\frac{1}{T_d}<\omega<-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_n.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_n-C_p-C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_n+2C_p-4C_m).\left(T_b/_F\right)(\omega).}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_n+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i-2C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_n.\left(T_b/_F\right)(\omega)}$$

(8) $\quad \frac{-2}{T_c}-\frac{1}{T_d}<\omega<\frac{-2}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)$$
$$=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(5C_m+2C_n-2C_l-2C_i-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{-2\pi jC_i.\left(T_b/_F\right).\omega}$$

$$+\frac{S.S_1.S_4}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i-2C_n+5C_m-2C_l-3C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right).\omega}$$
$$+\frac{S.S_2.S_4}{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right)}e^{2\pi j(2C_i+4C_n+3C_p-9C_m).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i+C_n+2C_p-4C_m).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i+2C_n+4C_p-8C_m).\left(T_b/_F\right)(\omega)}$$

$$+\frac{S.S_1.S_3}{2\pi j(C_i-C_n).\left(T_b/_F\right)}e^{2\pi j(2C_i+C_p-C_m-2C_l).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i-C_n).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i-2C_n).\left(T_b/_F\right)(\omega)}$$

(9) $\quad \frac{-4}{T_c}+\frac{1}{T_d}<\omega<-\frac{2}{T_c}-\frac{1}{T_d}$

$$X_{o_3}(\omega,z)$$
$$=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(5C_m+4C_n-2C_l-7C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(2C_i+2C_n-4C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_n-2C_p).\left(T_b/_F\right).\omega}$$

(10) $\quad \frac{-4}{T_c}-\frac{1}{T_d}<\omega<-\frac{4}{T_c}+\frac{1}{T_d}$

$$X_{o_3}(\omega,z)=E_3\sum_{m=1}^{k}\sum_{n=1}^{k}\sum_{p=1}^{k}\sum_{i=1}^{k}\sum_{l=}^{k}\frac{S.S_1.S_4}{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right)}e^{2\pi j(4C_i+5C_m+8C_n-2C_l-15C_p).\left(T_b/_F\right).\left(\frac{1}{T_c}\right).}e^{2\pi j(C_i+C_n-2C_p).\left(T_b/_F\right).\left(\frac{1}{T_d}\right).}e^{2\pi j(C_i+2C_n-4C_p).\left(T_b/_F\right).\omega}$$

(11) $\omega < \frac{-4}{T_c} - \frac{1}{T_d}$

$$X_{o_3}(\omega, z) = 0$$