

② LPF $s \rightarrow \frac{\omega}{P}$

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1} \rightarrow \frac{1}{\left(\frac{\omega}{2\pi f_c}\right)^2 + \sqrt{2}\left(\frac{\omega}{2\pi f_c}\right) + 1}$$

$$= \frac{(2\pi f_c)^2}{s^2 + (2\pi f_c)\sqrt{2}s + (2\pi f_c)^2}$$

$$H(z) = \frac{(2\pi f_c)^2}{\left(\frac{1-z^{-1}}{1+z^{-1}}\right)^2 + (2\pi f_c)\sqrt{2}\left(\frac{1-z^{-1}}{1+z^{-1}}\right) + (2\pi f_c)^2}$$

$$= \frac{(2\pi f_c)^2 (1+z^{-1})^2}{(1-z^{-1})^2 + (2\pi f_c)\sqrt{2}(1-z^{-1})(1+z^{-1}) + (2\pi f_c)^2 (1+z^{-1})^2}$$

$$= \frac{(2\pi f_c)^2 (1+2z^{-1}+z^{-2})}{(1-2z^{-1}+z^{-2}) + (2\pi f_c)\sqrt{2}(1-z^{-2}) + (2\pi f_c)^2 (1+2z^{-1}+z^{-2})}$$

$$= \frac{(2\pi f_c)^2 + 2(2\pi f_c)^2 z^{-1} + (2\pi f_c)^2 z^{-2}}{(1+2\pi f_c\sqrt{2} + (2\pi f_c)^2) + (-2 + 2(2\pi f_c)^2)z^{-1} + (1 - \sqrt{2}(2\pi f_c) + (2\pi f_c)^2)z^{-2}}$$

$$= \frac{p^2 + 2p^2 z^{-1} + p^2 z^{-2}}{(1 + \sqrt{2}p + p^2) + (-2 + 2p^2)z^{-1} + (1 - \sqrt{2}p + p^2)z^{-2}}$$

$$= \frac{\frac{p^2}{()} + \frac{2p^2 z^{-1}}{()} + \frac{p^2 z^{-2}}{()}}{1 + \frac{(-2 + 2p^2)}{(1 + \sqrt{2}p + p^2)} z^{-1} + \frac{(1 - \sqrt{2}p + p^2)}{(1 + \sqrt{2}p + p^2)} z^{-2}}$$

$$*() = (1 + \sqrt{2}p + p^2) \quad p = 2\pi f_c$$

② HPF $s \rightarrow \frac{2\pi f_c}{s}$ $2\pi f_c = p$

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1} \Rightarrow \frac{1}{\left(\frac{p}{s}\right)^2 + \sqrt{2}\left(\frac{p}{s}\right) + 1}$$

$$= \frac{s^2}{p^2 + \sqrt{2}ps + s^2}$$

$$H(z) = \frac{\left(\frac{1-z^{-1}}{1+z^{-1}}\right)^2}{p^2 + \sqrt{2}p\left(\frac{1-z^{-1}}{1+z^{-1}}\right) + \left(\frac{1-z^{-1}}{1+z^{-1}}\right)^2}$$

$$= \frac{(1-z^{-1})^2}{p^2(1+z^{-1})^2 + \sqrt{2}p(1-z^{-1})(1+z^{-1}) + (1-z^{-1})^2}$$

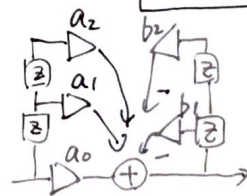
$$= \frac{1 - 2z^{-1} + z^{-2}}{p^2(1+2z^{-1}+z^{-2}) + \sqrt{2}p(1-z^{-2}) + (1-2z^{-1}+z^{-2})}$$

$$= \frac{1 - 2z^{-1} + z^{-2}}{(p^2 + \sqrt{2}p + 1) + (2p^2 - 2)z^{-1} + (p^2 - \sqrt{2}p + 1)z^{-2}}$$

$$= \frac{\frac{1}{()} - \frac{2}{()} z^{-1} + \frac{1}{()} z^{-2}}{1 + \frac{2p^2 - 2}{()} z^{-1} + \frac{p^2 - \sqrt{2}p + 1}{()} z^{-2}}$$

$$*() = (p^2 + \sqrt{2}p + 1)$$

$$p = 2\pi f_c$$



$$\frac{a_0 + a_1 z^{-1} + a_2 z^{-2}}{b_0 + b_1 z^{-1} + b_2 z^{-2}}$$

周波数 ($\omega \rightarrow \frac{2\pi f}{T}$)

$$f_a = \frac{1}{2\pi} \tan\left(\frac{f_c}{f_s} \pi\right)$$

デジタル上の周波数を
アナログ設定に反映する