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* M circles are used to determine the magnitude of CLTF using OLTF.

* Applicable only for unity feedback systems

$$M(j\omega) = G(j\omega) / 1 + G(j\omega)$$

$$G(j\omega) = x + jy$$

$$|M(j\omega)| = \sqrt{x^2+y^2} / \sqrt{(1+x)^2+y^2}$$

$$M^2(1+x^2) + M^2y^2 = x^2+y^2$$

$$x^2(1-M^2) + (1-M^2)y^2 - 2M^2x = M^2$$

$$x^2 + y^2 - \frac{2M^2}{1-M^2}x = \frac{M^2}{1-M^2}$$

adding $\left(\frac{M^2}{1-M^2}\right)^2$ in both sides we get

$$\left(x - \frac{M^2}{1-M^2}\right)^2 + y^2 = \left(\frac{M}{1-M^2}\right)^2$$

The above equation represents a family of circles with its center at $\left(\frac{M}{1-M^2}, 0\right)$ and radius

$$\left|\frac{M}{1-M^2}\right|$$

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