Rectangular to Polar Coordinates

$a^2+b^2=c^2$ $\quad\quad$ $c=\sqrt{a^2+b^2}$

$R^2+X^2=Z^2$ $\quad\quad$ $Z=\sqrt{R^2+X^2}$

$\tan(\theta)=\frac{Opposite}{Adjacent}=(\frac{X}{R})$ $\quad\quad$ $\theta=\arctan(\frac{Opposite}{Adjacent})=\arctan(\frac{X}{R})$

Polar to Rectangular Coordinates

$\cos(\theta)=\frac{Adjacent}{Hypotenuse}=\frac{R}{Z}$ $\quad\quad$ $R=Hypotenuse\times\cos(\theta)=Z\cos(\theta)$

$\sin(\theta)=\frac{Opposite}{Hypotenuse}=\frac{X}{Z}$ $\quad\quad$ $X=Hypotenuse\times\sin(\theta)=Z\sin(\theta)$

Example

$3+j4\Omega=5\Omega, 53.1\ Degree\ Phase\ Angle$

Complex Impedance Rules

$Admittance=\frac{1}{Impedance}=Y=\frac{1}{Z}$ $\quad\quad$ Admittance,

$Conductivity=\frac{1}{Resistance}=G=\frac{1}{R}$ $\quad\quad$ Conductivity,

$Susceptance=\frac{1}{Reactance}=B=\frac{1}{X}$ $\quad\quad$ & Susceptance all have units of Siemens

- X_L is Positive
- X_C is Negative
- Impedances in Series Add Together
- Admittances in Parallel Add Together
- $\frac{1}{j}=-j$
- Voltage is the reference for Phase Angle Polarity
- Converting Phase Angles from Impedance to Admittance (and vice versa) changes the sign

Time Constant

$$\tau = RC$$

Inductive Reactance

$$X_L = 2\pi f L$$

Capacitive Reactance

$$X_C = \frac{1}{2\pi f C}$$

Power

$$P_{Series} = I^2 R$$

$$P_{ParallelI} = E^2 R$$

Power Factor

$$PF = \frac{P_{Real}}{P_{Apparent}} = \cos(Phase\ Angle)$$

Circuit Q

$$Q_{Series} = \frac{X}{R}$$

$$Q_{ParallelI} = \frac{R}{X}$$

Resonant Frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Half Power Bandwidth

$$\Delta f = \frac{f_r}{Q}$$

Toroid Inductance

$$L_{IronPowder} = \frac{A_L \times (Number\ of\ Turns)^2}{10{,}000}$$

Op Amp Gain

$$Voltage\ Gain = |A_V| = \frac{R_F}{R_1}$$

Frequency Counter Error

$$Error_{Hz} = \frac{f_{Hz} \times CounterError_{ppm}}{1{,}000{,}000}$$

Intermodulation

$$f_{imd} = 2f_1 - f_2$$

$$f_2 = 2f_1 - f_{imd}$$

FM Deviation Ratio

$$Deviation\,Ratio = \frac{Deviation_{MAX}}{ModulatingFreqency_{MAX}}$$

FM Modulation Index

$$Modulation\,Index = \frac{Deviation_{MAX}}{ModulatingFrequency_{Instant}}$$

Digital Signal Bandwidth

$$BandWidth = BaudRate \times KeyingEnvelope$$

$$BandWidth_{CW} = (0.8 \times WPM) \times 5$$

$$BandWidth_{FSK} = (1.2 \times Shift) + BaudRate$$

Isotropic & Dipole Antenna Gain

$$dB_{dipole} = dB_{isotropic} - 2.15\,dB$$

$$dB_{isotropic} = dB_{dipole} + 2.15\,dB$$

Antenna Efficiency

$$Efficiency = \left(\frac{R_{Radiation}}{R_{Total}}\right) \times 100 = \left(\frac{R_{Radiation}}{R_{Radiation} + R_{Ohmic}}\right) \times 100$$

Effective Radiated Power

$$ERP = TPO \times SystemGain = TransmitterPowerOutput \times 10^{\frac{Gain_{dB}}{10}}$$

Note: SystemGain is in Watts

Velocity Factor

$$VF = \frac{Velocity_{WaveConductor}}{Velocity_{LightVacuum}}$$

Power Measurement

$$P_{Load} = P_{Forward} - P_{Reflected}$$

Synchronous Transformer

$$Z_{SynchronousTransformer} = \sqrt{Z_{Line} Z_{Load}}$$