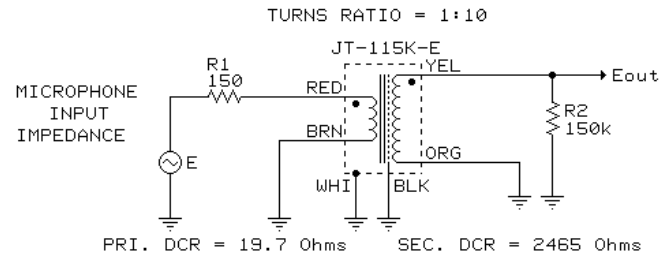
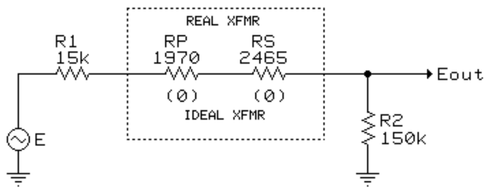
HOW TO CALCULATE TRANSFORMER RELATED NOISE FIGURE



EXAMPLE TRANSFORMER CIRCUIT



REDRAWN CIRCUIT WITH ALL IMPEDANCES REFLECTED TO SECONDARY.

PRIMARY SIDE IMPEDANCES GET MULTIPLIED BY THE SQUARE OF THE TURNS RATIO.

1) $R1 = 150 \text{ Ohms} \times (10)^2 = 15k$

2) $RP = 19.7 \text{ Ohms} \times (10)^2 = 1970$

3) RS = SECONDARY DCR = 2465

4) R2 = 150k (LOAD)

THE TRANSFORMER NOISE FIGURE IS CALCULATED BY COMPARING A REAL TRANSFORMER WITH ITS WINDING RESISTANCES TO AN IDEAL TRANSFORMER WITH NO WINDING RESISTANCES.

FIRST, TRANSFORM ALL IMPEDANCES TO THE SECONDARY AS SHOWN TO THE LEFT.

THERE ARE TWO COMPONENTS TO THE CALCULATION:

1) THE ADDITIONAL NOISE DUE TO THE INCREASED OUTPUT IMPEDANCE.

$$\text{REAL Zout } \frac{150k \times (15k + 1970 + 2465)}{150k + 15k + 1970 + 2465} = 17k206$$

$$\text{IDEAL Zout } \frac{150k \times 15k}{150k + 15k} = 13k636$$

$$\text{NF} = 20 \text{ Log} \sqrt{\frac{17k206 \text{ (REAL)}}{13k636 \text{ (IDEAL)}}} = 1.01\text{dB}$$

2) THE DECREASE IN SIGNAL LEVEL AT THE OUTPUT DUE TO THE INCREASED SERIES LOSSES.

$$\text{IDEAL Eout } \frac{150k}{150k + 15k} = 0.909$$

$$\text{REAL Eout } \frac{150k}{150k + 15k + 1970 + 2465} = 0.885$$

$$\text{NF} = 20 \text{ Log } \frac{0.909 \text{ (IDEAL)}}{0.885 \text{ (REAL)}} = 0.232\text{dB}$$

3) TOTAL NF = 1.01dB + 0.232dB = 1.233dB

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