Using the Optional Resistor Bank to Improve the Antenna Bandwidth

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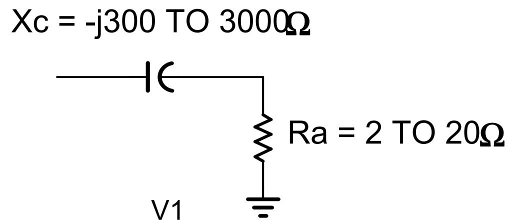
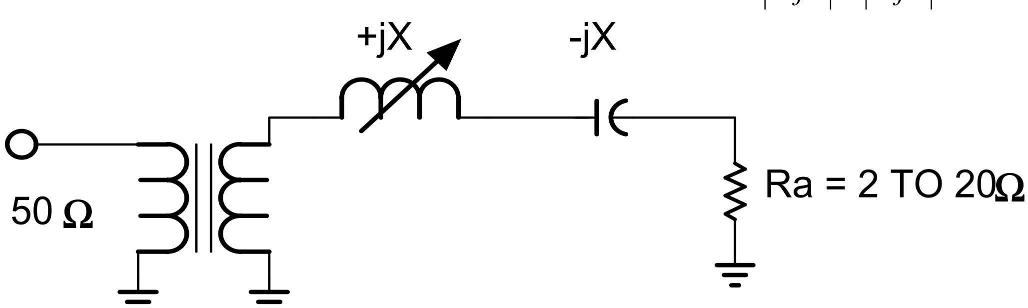
The height of a typical NDB antenna is much shorter than the ideal value.
As a result, the antenna input impedance appears as a small resistance in series with a high capacitive reactance.



The Antenna Tuning Unit resonates the capacitor with a loading coil at the operating carrier frequency (Fc) and transforms the resulting low resistance to 50ς using an RF transformer.

$$Where \left| +jX \right| = \left| -jX \right|$$



As a result, the antenna acts as a bandpass filter, tuned to Fc with a Q value = $\left(\frac{X}{R}\right)$

that can vary between $\left(\frac{3000}{2}\right)$ or 1500 and $\left(\frac{300}{20}\right)$ or 15.

The resulting antenna bandwidth is given by the expression BW= $\left(\frac{fc}{Q}\right)$

Hence, in the worse case condition where Fc=190kHz, and Q=1500, the bandwidth would be $\left(\frac{190}{1500}\right)$ = 127 Hz.

Fortunately, with practical antennas, these worst case conditions almost never occur, however, Q values as high as several hundred and bandwidths less than 1000 Hz are common.

<u>Necessary Bandwidth</u>
The spectrum of an NDB signal extends to twice the highest modulating frequency and hence is dependent upon the frequency of the identification tones and, where used, the modulating voice signal. 400 Hz identification tones are sometimes used instead of 1020 Hz to minimize the necessary bandwidth.

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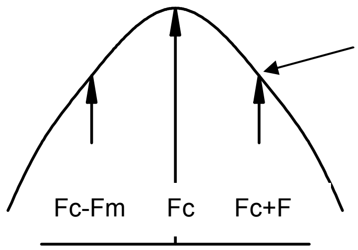
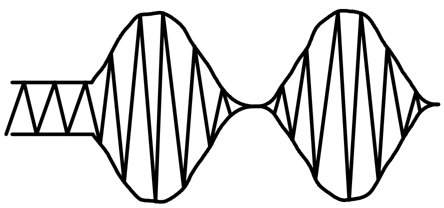
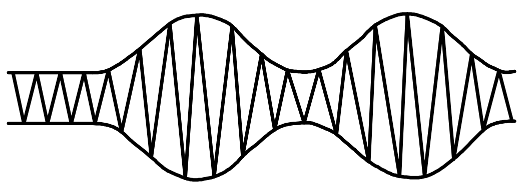


Result

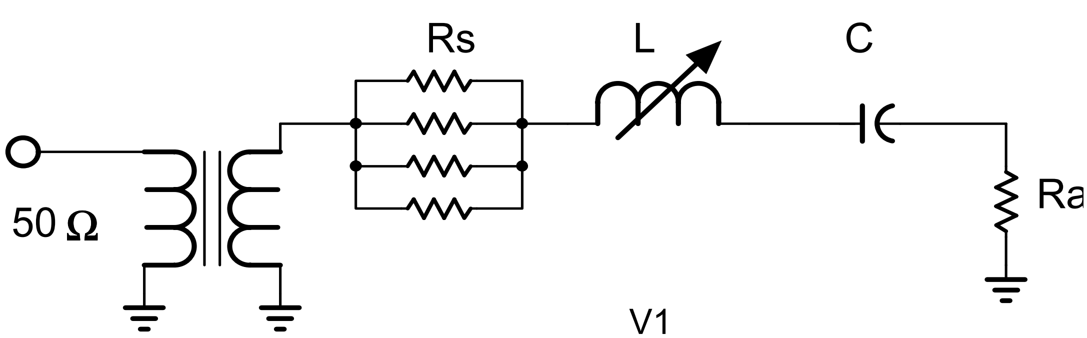


Input to Antenna



Radiated Signal

As an option, the ATU can contain a built-in resistor group which may be connected in series with the loading coil to lower the Q of the antenna and hence broaden the bandwidth.



To calculate the antenna bandwidth for a particular installation:

1. Determine the loading coil inductance and antenna resistance (R_A) from installation records. If the antenna resistance (R_A) cannot be obtained from installation records, the following method may be used to determine the antenna resistance (R_A):

Note the forward power and antenna current on ATU meter in CW mode (no modulation).

Note that Forward Power = $I_a^2 x R_A$

Calculate R_A = $\frac{Forward\ Power}{I_a^2}$

2. Calculate X_L = $\left(\frac{6.28 x fc(kHz) x Coil\ Inductance(\mu H)}{1000}\right)$

3. Calculate Antenna Q_A = $\left(\frac{X_L}{R_A}\right)$

4. Calculate Antenna Bandwidth = $\left(\frac{f_c}{Q_A}\right)$

Repeat 3 and 4 using Q_A= $\left(\frac{X_L}{R_A + R_S}\right)$ to determine improved bandwidth.

Note: Use of R_S will lower the overall antenna efficiency by a factor approximately equal to $\left(\frac{R_A}{R_A + R_S}\right)$