Design & Construction of Antenna Couplers

Introduction.

Wen using more then one antenna, a coupler will be needed to take advantage of the increased gain for both antenna's. a theorethical value of 3dB increase when doubling the antenna should not be treated as a reachable goal. Several hams use an open feeder system, which will have very good results in coupling.
Unfortunately I have no experience with open feeders, but I can imagine the advantage due to absence of impedance transformers required for coaxial lines.
However seems an open feeder system is more sensitive to its climatical environment. For this reason it might need regular maintenance. Imagine your antenna's are high in the sky!
So for this only reason I stucked with traditional coaxial interfacing lines between various antenna's.

Calculation.

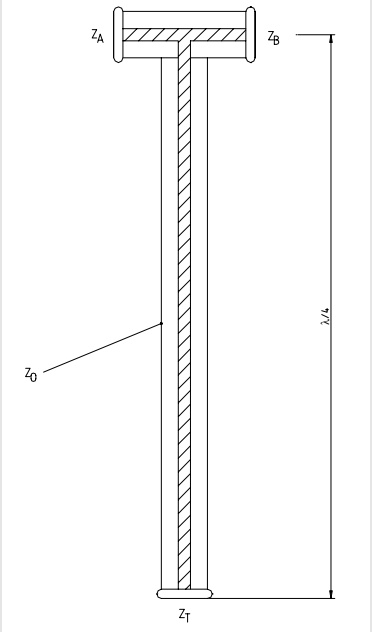
Designing a coupler, some simple calculations and ruls as sufficient to dperform the job. Using copper plumbing materials will provide you with a sufficient wide choice of tubes to construct an antenna coupler.

RULE: *Impedance transfer must be done in a λ/4 section.*

The transfer ipedance needed in a certan situation can be calculated using following formula:

Zo = SQRT(Za x Zt)

Where:
Zo = transfer impedance
Za = impedance at side A (usual Antenna side)
Zt = impedance at side T (usual Tx side)



Example 1:
Two antennas, each 50Ohm, must be coupled using besides figure.

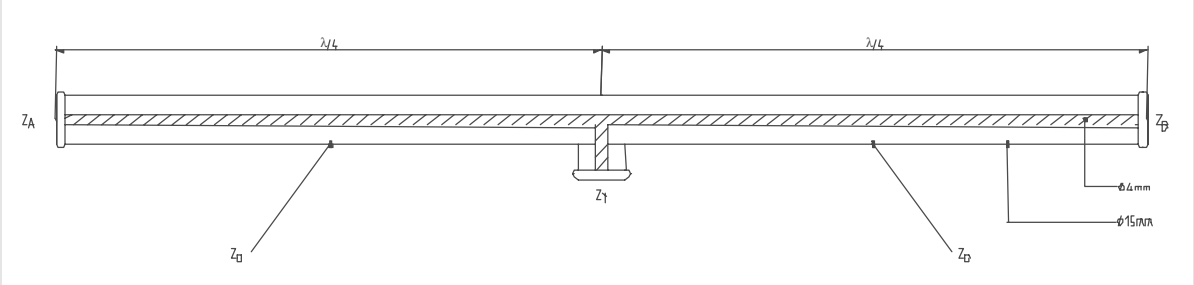
Solution:
The impedance Za = 50Ohm / 2 = 25 Ohm
While Zt= 50 Ohm

Zo = SQRT (25 x 50) = 35.4 Ohm

Example 2:
Two antennas, each 50Ohm, must be coupled using below construction.

Solution:
The impedance Za = 50 Ohm, while Zt= 100 Ohm in order to match for two antenna sections

Zo = SQRT (50 x 100) = 70.7 Ohm

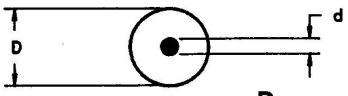


Once understanding above type of caculations virtually any combination of antenna's can be coupled.

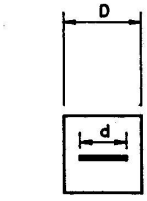
RULE: *Use identical lengths of coaxial cables from the coupler to each antenna.*

Construction.

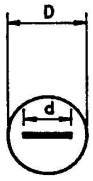
After the calculation is performed several ways of construciton can be used to manufacture the coupler. How to create the required transfer impedance Zo depends on the selected materials. Below formulas and graphs will help to calculate material dimensions needed.
Myself I prefer to use plumbers copper tubes such as 15mm outer dimater. The advantage is that for this type of tubes many additional pieces, T-sections , reduction section etc are available to help in construction.



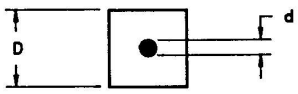
$$Z_0 = 138 \ LOG \frac{D}{d}$$



$$Z_0 = 60 \ LN \ 2.16 \frac{D}{d}$$



$$Z_0 = 60 \ LN \ 2 \frac{D}{d}$$



$$Z_0 = 138 \ LN \frac{1{,}178D}{d}$$

Practical example.

432MHz coupler for two antenna's

ʎ/4 wavelength:	17.35cm
Zo :	70.7 Ohm
D/d:	3.3
Outerdiameter D:	12 mm copper tube with inside diam: 10mm
Inner diameter d:	3mm