W4OVH FIELD DAY TRAINING ACTIVITY: ANTENNA (ETC) MATCHING WITH COAX STUBS

COAX CABLE AVAILABLE IN CHARACTERISTIC IMPEDANCES FROM ABOUT 10 TO 125 OHMS

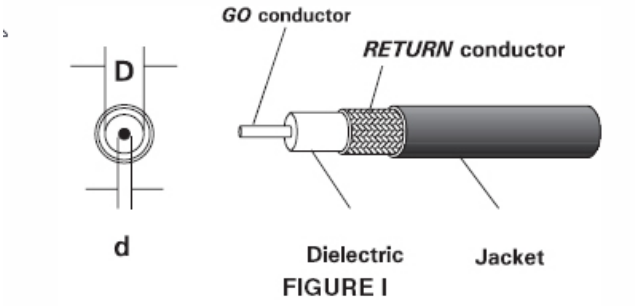


FIGURE I

$$Z_0 = (138 / \sqrt{E}) \times \log_{10} (D / d)$$

where:

Z_0 = Characteristic impedance

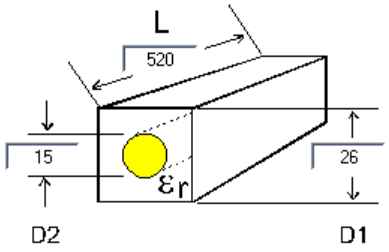
E = Dielectric constant (air is 1.0), see Table 5.

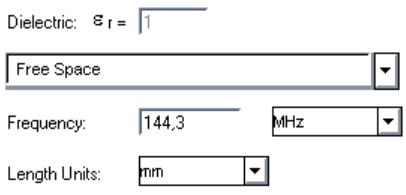
D = Inside diameter of the "*return*" (outer) conductor (conductive metal tube or one or more braids), see Figure 1.

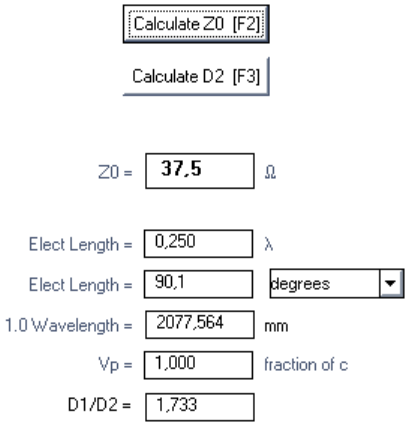
d = Outside diameter of the "go" (inner) conductor, see Figure 1.

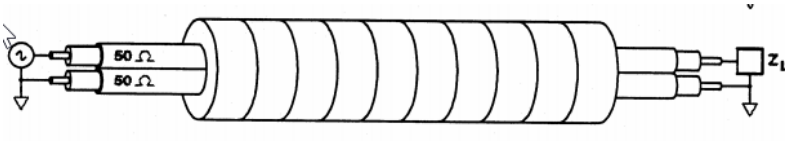
CABLES CAN BE CONNECTED IN SERIES/PARALLEL TO OBTAIN NON STANDARD VALUES – FOR EXAMPLE 50 OHMS AND 75 OHMS IN PARALLEL RESULTS IN 30 OHMS = $1 / (1/Z_1 + 1/Z_2)$

Square Coax









Series connection – 100 ohm

SPECIAL CASE OF STUB MATCHING – THE QUARTER WAVE TRANSFORMER (QWT)

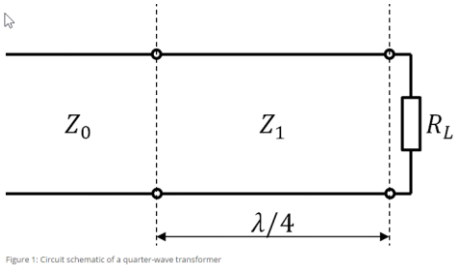


Figure 1: Circuit schematic of a quarter-wave transformer

Z_1 = SQRT (Z_0 * R_L) - THIS IS THE GEOMETRIC MEAN OF THE TWO IMPEDANCES TO BE MATCHED

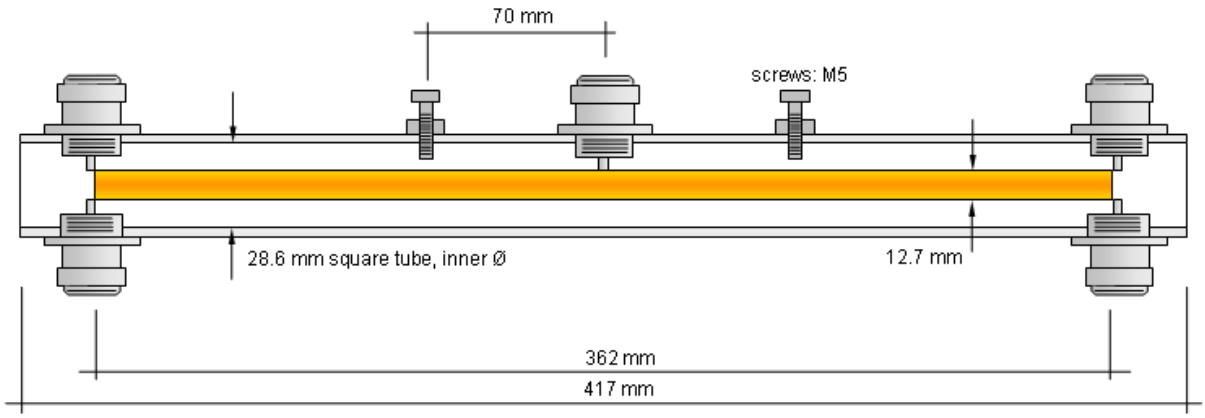
ALSO: $Z_0 = Z_1 * Z_1 / R_L$

COMMON USE – FEEDING 2 OR MORE ANTENNAS EACH WITH 1:1 SWR.

USE QWT TO TRANSFORM 50 OHMS TO 100, THEN PARALLEL THE TWO ANTENNAS. REPEAT FOR 4 OR 16 ANTENNAS. (QWT CAN STEP UP OR STEP DOWN)

4-WAY CAN BE MADE WITH 50 OHM COAX

FOR HIGHER FREQUENCIES SOLID TUBING IS MORE CONVENIENT/PRACTICAL



NOTES – THE QWT PRODUCES THE DESIRED RESULT IF THE LOADS ARE ENTIRELY RESISTIVE (!)

CONNECTORS SHOULD BE LOCATED AT POINT WHERE THE IMPEDANCE MATCHES THE CONNECTOR (50 OHMS USUALLY)

DEPENDING ON THE CONSTRUCTION, THE "LENGTH" OF THE CONNECTOR MAY FACTOR INTO THE CALCULATIONS

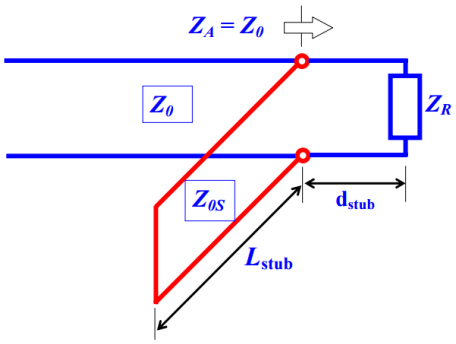
QWT IS A SPECIAL CASE OF IMPEDANCE TRANSFORMATION BY TRANSMISSION LINE. MOST EXPLANATION USE THE SMITH CHART

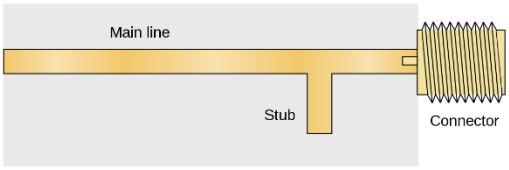
[SIMSMITH DEMONSTRATION HERE]

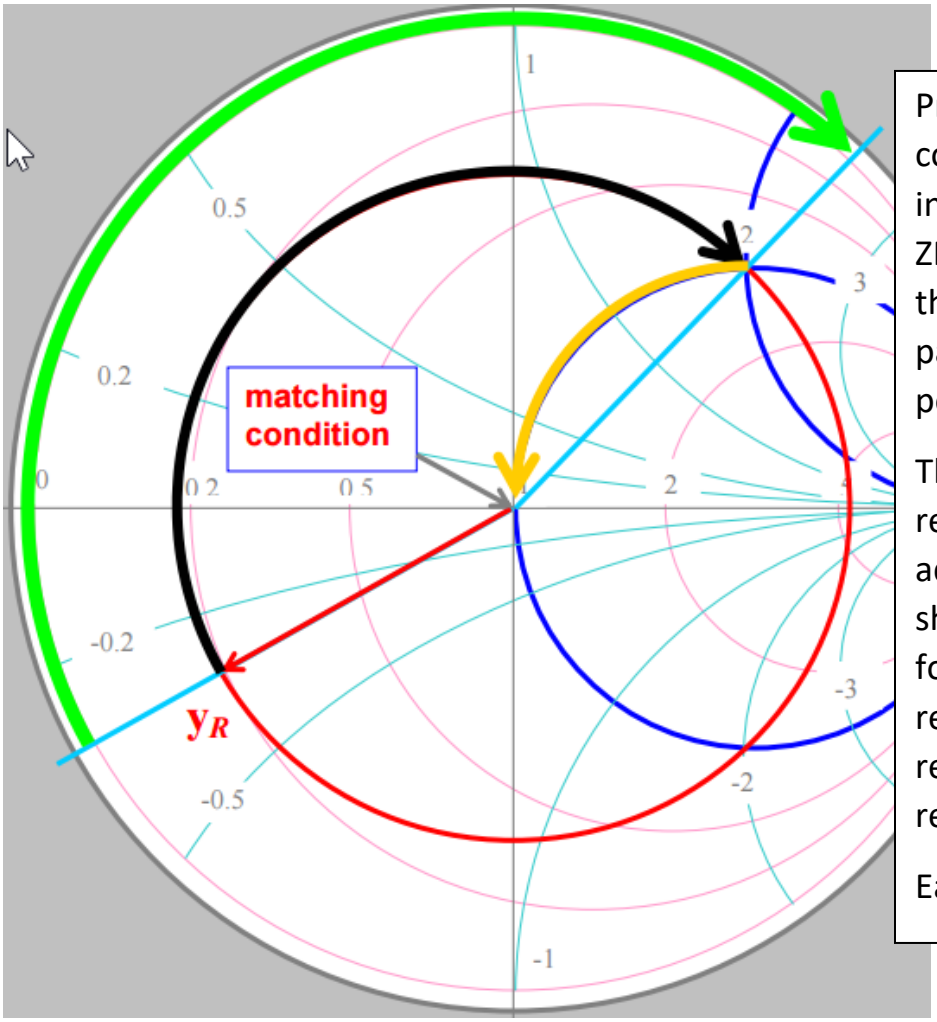
STUB MATCHING

OPEN AND SHORT-CIRCUITED STUBS EXHIBIT CAPACITIVE OR REACTIVE IMPEDANCE AT THE POINT OF ATTACHMENT. REACTANCE SIGN DEPEND ON THE LENGTH > OR < ¼ WAVE.

IMPEDANCE VALUE IS FREQUENCY–DEPENDENT, SO MATCH IS "NARROW-BAND"







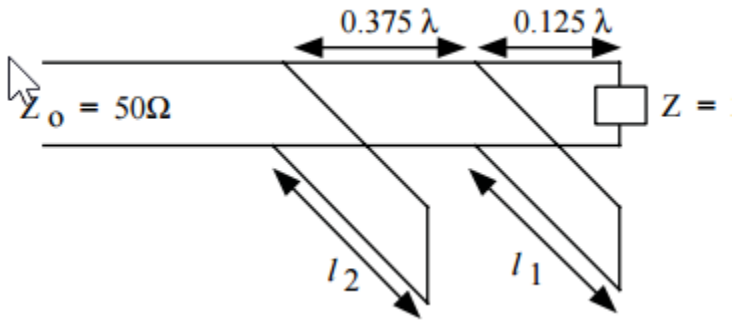
Procedure: Follow the constant SWR circle that includes starting impedance ZR (red one) until you reach the constant resistance circle passing through the 50 ohm point (blue one).

Then correct for the reactance. This is done by adjusting the length of the shunt stub (Lstub) which follows the constant resistance circle but adds reactance until 50+j0 is reached.

Easy to do with SimSmith!

THERE ARE ALSO TWO STUB AND THREE STUB VERSIONS OF THE STUB MATCH

DOUBLE-STUB HAS FIXED LENGTH OF LINES AND BOTH STUBS ARE ADJUSTED FOR LOAD MATCH (CONVENIENT FOR PCB STRIP LINE SITUATIONS)



SOME IMPEDANCE PAIRS CANNOT BE MATCHED WITH THIS

(Analysis of this circuit is beyond the scope of this talk).

REFERENCES

http://www.amanogawa.com/archive/docs/I-tutorial.pdf

http://www.ae6ty.com/papers_files/qrparticle.pdf

(downloads at http://ww.ae6ty.com/Smith_Charts.html **)**

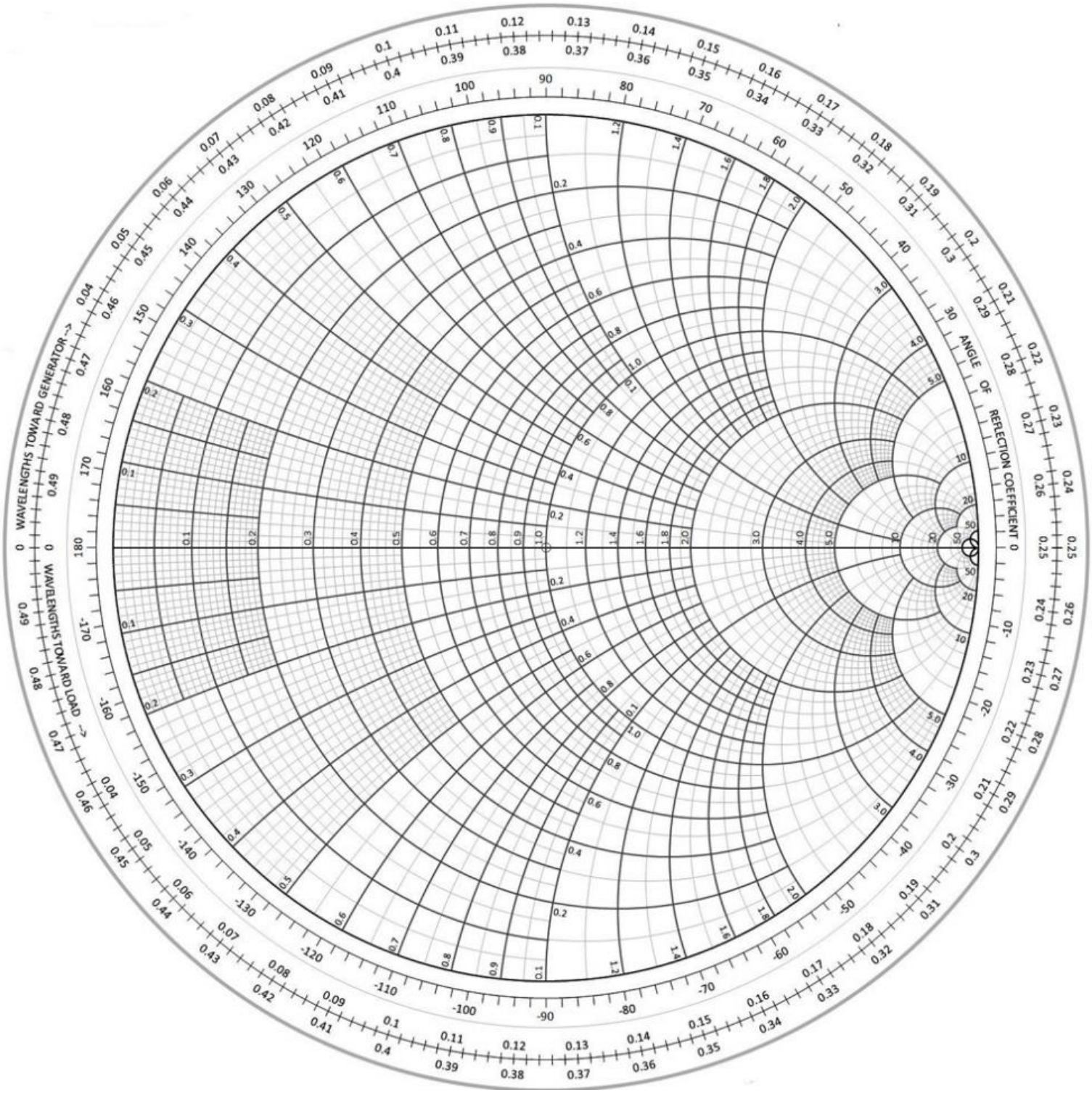
http://www.arrl.org/files/file/Antenna%20Book%20Supplemental%20Files/22nd%20Edition/Smith%20Chart%20Supplement%20-%20Corrected%20Jan%202012.pdf

http://www.qsl.net/dk7zb/Stacking/splitter.htm

http://www.engr.sjsu.edu/rkwok/EE172/Impedance_Matching.pdf

http://www.amanogawa.com/archive/DoubleStub/DoubleStub-2.html **(Unfortunately this applet does not work with any modern-day browser)**

http://www.qsl.net/dk7zb/Stacking/coax.htm


WAVELENGTHS TOWARD GENERATOR -->
WAVELENGTHS TOWARD LOAD -->
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