Matching for Maximum Power Transfer

an overview
Maximum Power Transfer at $R_i = R_L$
Conjugate match

- A complex impedance source \( Z_i = R_i + jx_i \) transfers maximum power if the load is its complex conjugate \( Z_A = Z_i^* = R_i - jx_i \)
Matching a transmission line

• If power travels along a transmission line (e.g. coaxial cable) with a characteristic impedance $Z_0$ and is unmatched to the load, where does the excess power go?
Matching a Transmission Line

• The power is reflected
  – With a continuous source signal (wave) (CW) this creates a standing wave

• Usually we want to match a load to the transmission line
  – Performed using a lossless impedance changing matching circuit
Matching Circuits

• Simple L, Pi and T-section circuits are usually used
• No resistances, so no loss (with ideal components)
• Aren’t these filter circuits?
• Yes. Matching circuits have a band of operation
The Smith Chart

- Excellent tool for visualising complex impedances and calculating and describing matching methods
- Four diagrams overlaid
  - Reflection circles (phase change)
  - Admittance
  - Reactance
  - Resistance
- Extensively used in RF engineering
- Duplicated in RF analyser displays
References

Diagrams in these notes are taken from the following sources, which are also recommended for further reading:

http://hyperphysics.phy-astr.gsu.edu/hbase/electric/powtran.html a simple optimum power calculator
http://www.afs.secure-endpoints.com/afs/ece/u/tms/impmatch.pdf proceedings paper on maximum power matching, and when it is good to use and sometime when it isn’t
http://www.ittc.ku.edu/~jstiles/723/handouts/section_5_1_Matching_with_Lumped_Elements_package.pdf a good read on matching, illustrated with Simpson’s characters!
http://electronicdesign.com/communications/back-basics-impedance-matching-part-2 another article on impedance matching
http://home.sandiego.edu/~ekim/e194rfs01/jwmatcher/matcher2.html a comprehensive matching circuit calculator
http://www.cwtd.org/CWTD_Handouts.html an extraordinary collection of very good concise advice and information, including on matching
http://www.renesas.com/support/faqs/faq_results/Q1000000-Q9999999/design/tech/tech_106gl.jsp a short tutorial on the Smith chart
http://www.engineering-electronics.com/html/smith_chart_course.html A comprehensive course on Smith chart techniques