

N9LYA TECHNICAL GUIDES

Microwave Communications Electronics

RF Fundamentals and Applications

Jerome M. Kutche

N9LYA

Second Edition · September 2026

About This Book

There are two kinds of RF books. The first is a textbook: rigorous, full of Maxwell's equations in their glory, and largely silent on what happens when a technician hands you a radio that "just stopped working" and needs to be back on the air by end of shift. The second is a ham radio "getting started" guide: friendly, project-based, and it stops right around the point where you'd actually need to understand why your antenna isn't behaving the way the book said it would.

This book is written from a third position. From 1990 to 1996 I built RF test and measurement equipment for the telecommunications and cable television industries at Applied Instruments in Indianapolis, alongside engineers Doyle Haywood, David Polstra, and Jerry Brown. That job was not theoretical. Gear either passed calibration or it didn't, a filter either met its spec or it went back to engineering, and a signal either got where it was going clean or it didn't and someone had to find out why. I've been a licensed amateur radio operator since 1991, upgraded to General in 2003, and I've worked contacts through the Space Shuttle SAREX program, the Mir space station, and the International Space Station on a two-watt handheld — which teaches you something about link budgets that no textbook problem set does.

That background shapes what this book emphasizes.

Transmission line theory gets treated as something you use, not just something you prove. The Smith chart chapter exists because most people are taught the Smith chart exists and then never taught how to actually read one under time pressure at a bench.

Test equipment gets four full chapters, because knowing what a mixer does in principle is not the same skill as knowing how to find out why this particular mixer, in this particular radio, is producing a spur where there shouldn't be one.

There is a full section on applied systems — cable plant, satellite and microwave backhaul, cellular basics, ham VHF/UHF/microwave — because RF theory without a system to hang it on evaporates within a week of finishing the book.

Troubleshooting and interference hunting each get dedicated chapters, and they are, in my experience, the most valuable and least-taught skills in this entire field.

Who This Is For

Electronics technicians and hobbyists who understand DC and basic AC circuits and want to extend into RF. Part I assumes you know Ohm's law and can read a schematic; it does not assume you've touched a Smith chart before.

Licensed amateur radio operators who passed the theory exam and want the "why" behind the "what" — particularly around transmission lines, antennas, and interference, which the license manuals cover thinly.

Field and bench technicians working on cable, satellite, or two-way radio systems who need practical test-and-measurement skill, not a derivation of the wave equation.

Anyone chasing an interference problem right now. Chapter 23 is written to be read out of order if that's why you picked up this book.

How to Use It

Each chapter closes with a **Bench Check** — questions and small hands-on exercises. RF is unusually easy to feel like you understand from reading alone, because the physics is invisible; you don't see the wave, you see a meter reading or a trace on a screen. The Bench Check exercises exist to close the gap between reading about a standing wave and actually watching one move a VSWR needle when you shorten a stub.

Formulas are given in plain notation — $Z_0 = V / I$ rather than typeset mathematics — because that's how you'll actually write them on a service ticket or a notepad at the bench.

Where I recommend test equipment, I describe the class and the specifications that matter rather than a specific model that will be discontinued by the time you read this.

A Word Before You Start

RF has a reputation for being harder than it is, mostly because it’s invisible and because early exposure is often a wall of equations with no bench context attached. It is a physical, measurable, learnable craft — I’ve watched people who could barely explain a capacitor learn to read a Smith chart competently in an afternoon, once someone showed them what the chart is actually for.

It also has real hazards that a lot of introductory material glosses over — RF burns, and at sufficient power density it cooks tissue the same way a microwave oven cooks food, because it’s the same physics. Chapter 24 covers this properly. Read it before you stand in front of a transmitting antenna at close range.

About the Author

Jerome M. Kutche holds the amateur radio callsign N9LYA, first licensed in 1991 and upgraded to General class in 2003. His interest in electronics was sparked in the early 1970s by a mentor named Frank Kime, and his understanding of interference and grounding owes a great deal to the late Mike Baugh, W8AKF, an RFI mentor of rare patience.

From 1990 to 1996 he worked at Applied Instruments in Indianapolis, building RF test and measurement equipment for the telecommunications and cable television industries, alongside engineers Doyle Haywood, David Polstra, and Jerry Brown.

He then moved into industrial electrical and controls work, accumulating more than three decades across manufacturing, materials, and heavy industry — Allen-Bradley and Siemens PLC systems, motor control centers, plant electrical maintenance and supervision. He holds NFPA 70E, lockout/tagout, arc flash, and thirty-nine other professional certifications.

He has worked amateur radio contacts through the Space Shuttle SAREX program, the Mir space station, and the International Space Station, using a two-watt handheld radio.

Part I — RF Foundations

Chapter 1: Frequency, Wavelength, and the Spectrum

Everything in this book is a variation on one relationship:

$$c = f \times \lambda$$

The speed of light (c , about 3×10^8 meters per second in free space), equals frequency (f , in hertz) times wavelength (λ , in meters). Know the frequency, you know the wavelength, and vice versa. That’s the whole idea, and almost everything else in RF is what happens when you try to launch, guide, or receive a wave of a particular wavelength using hardware of a particular size.

Why wavelength matters more than frequency, practically. A circuit is “RF” not at some fixed frequency but when its physical dimensions become a meaningful fraction of a wavelength — typically taken as a tenth of a wavelength or more. At 60 Hz, a wavelength is about 5,000 kilometers, so a wire across your bench is electrically nothing. At 2.4 GHz, a wavelength is about 12.5 centimeters, so a wire across your bench is a transmission line, an antenna, or a source of unwanted radiation, whether you intended it or not. This is the single biggest mental shift moving from electronics into RF: **wires stop being wires and start being distributed elements.**

The spectrum, in the ranges you’ll actually work with:

Band	Range	Typical Use
HF	3–30 MHz	Shortwave, amateur HF, ionospheric propagation

Band	Range	Typical Use
VHF	30-300 MHz	FM broadcast, amateur 2m, public safety, aviation
UHF	300 MHz-3 GHz	Cellular, amateur 70cm, land mobile, GPS
Microwave (L-Ku)	1-18 GHz	Satellite, point-to-point links, radar, Wi-Fi
Microwave (K and above)	18 GHz+	Backhaul, automotive radar, some satellite

Propagation changes character by band, and this drives everything about system design. HF bounces off the ionosphere and can go worldwide on low power. VHF and UHF are mostly line-of-sight with some diffraction and tropospheric effects. Microwave is essentially pure line-of-sight — an obstruction that a VHF signal would diffract around will simply block a microwave link. This is why point-to-point microwave systems are engineered around Fresnel zone clearance (Chapter 19) rather than “will it reach.”

Decibels — the unit you’ll use constantly. RF signal levels span an enormous range, from picowatts at a sensitive receiver input to kilowatts at a transmitter output. Decibels compress that range into workable numbers because they’re logarithmic and, critically, gains and losses in a chain add and subtract instead of multiplying and dividing.

$$\text{dB} = 10 \times \log_{10}(P_2 / P_1)$$

Memorize two reference points and you can estimate almost anything in your head: **3 dB is a factor of 2** in power, and **10 dB is a factor of 10**. A 6 dB loss is a factor of 4 (two 3 dB halvings). A -20 dB loss is a factor of 100. This mental shortcut will save you more time at a bench than any formula in this book.

dBm is decibels referenced to 1 milliwatt — an absolute power unit, not a ratio, and the one you’ll see on every piece of RF test equipment. 0 dBm is 1 mW. +30 dBm is 1 watt. -100 dBm, a typical weak-signal receiver sensitivity, is 0.0000000001 milliwatts. You will never write that number out in practice; you’ll say “minus one hundred dBm” and everyone will know exactly what you mean. That’s the entire point of the unit.

Regulatory Spectrum Allocation

Spectrum is a shared, finite resource, and every band you’ll work in — from the AM broadcast band through millimeter-wave — is allocated by regulatory bodies (the FCC in the United States, coordinated internationally through the ITU) to specific services, often with multiple services sharing a band under defined priority and technical conditions. This isn’t bureaucratic trivia; it directly shapes what you’re allowed to build and how.

Primary and secondary allocations matter in practice: a secondary service (amateur radio shares several bands on a secondary basis) must not cause interference to a primary service and must accept interference from it — which is why, for instance, certain amateur allocations near primary radiolocation or federal government use come with specific geographic or power restrictions that aren’t obvious from the band plan alone unless you check the actual allocation table.

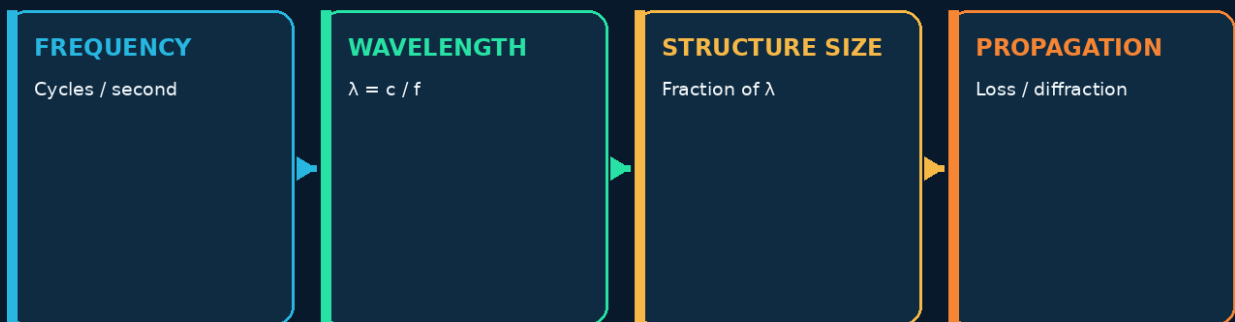
Type acceptance and equipment authorization govern what transmitting equipment can legally be sold and operated in a given service — an amateur radio operator can legally build and operate homebrew transmitting equipment on amateur bands, a privilege most other radio services don’t extend to end users, precisely because amateur licensing already establishes the technical competence the equipment-authorization process exists to guarantee for everyone else. Understanding this distinction matters directly for anyone tempted to repurpose amateur-band homebrew techniques on a Part 15 (unlicensed) or licensed commercial band, where the equipment itself — not just the operator — must be authorized before it can legally transmit.

Bench Check

1. What is the wavelength at 146 MHz (2m amateur band), and at what physical dimension does an object become “RF-significant” at that frequency?

Frequency and Wavelength

Higher frequency means shorter wavelength



N9LYA TECHNICAL GUIDES

Figure 1: Frequency and wavelength relationships

2. A signal goes through an amplifier with 13 dB gain and then a cable with 4 dB loss. What is the net gain in dB, and approximately what power ratio does that represent?
3. Convert 1 watt to dBm without a calculator, using only the “3 dB doubles, 10 dB times ten” shortcuts.
4. Why does an obstruction that a 2m signal diffracts around completely block a 12 GHz microwave link?

Chapter 2: Transmission Lines and Impedance

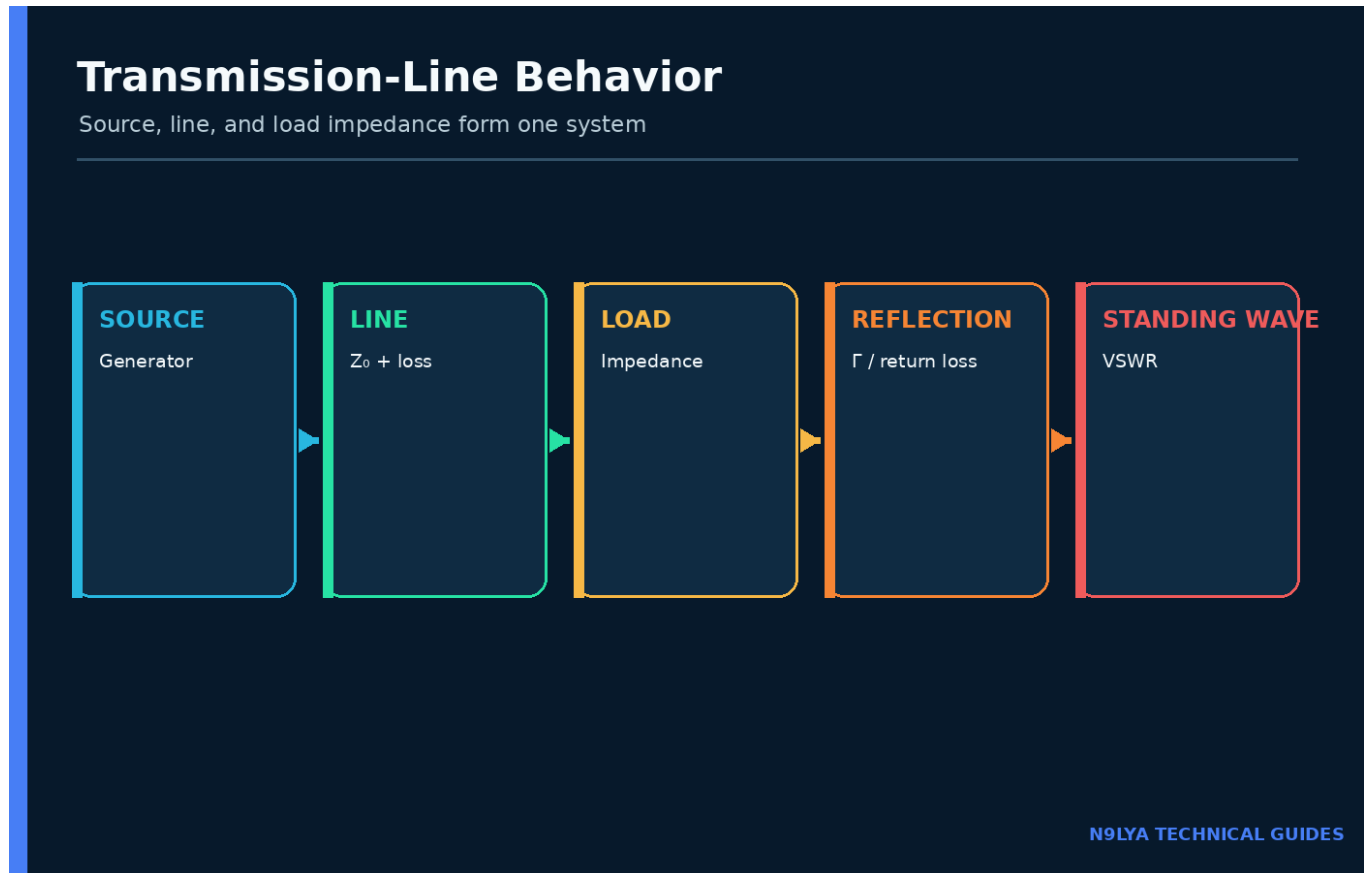


Figure 2: Transmission-line behavior

A transmission line is any conductor pair — coax, twin-lead, a PCB trace over a ground plane — used to carry a signal whose wavelength is short compared to the line’s length. Below that regime, a wire is just a wire with negligible impedance of its own. Above it, the wire itself has a characteristic impedance that governs how the signal behaves along its length, independent of what’s connected at either end.

Characteristic impedance (Z_0) is a property of the line’s geometry and the dielectric between the conductors — not of the source, the load, or the frequency (to first order). For coax:

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

where D is the inner diameter of the shield, d is the diameter of the center conductor, and ϵ_r is the dielectric constant of the insulation. This is why 50-ohm coax and 75-ohm coax are physically different cables, not the same cable used two different ways — the ratio of D to d is baked into the geometry at manufacture.

Why 50 ohms and 75 ohms specifically? Neither is arbitrary. For air-dielectric coax, minimum attenuation occurs near 77 ohms, and maximum power-handling occurs near 30 ohms. Fifty ohms is the compromise adopted for transmitting systems — reasonable loss, reasonable power handling.

Seventy-five ohms was chosen for receive-only video and cable systems where the loss minimum mattered more than power handling, since nothing downstream is transmitting significant power back up the line. That single design decision, made decades ago, is why you cannot casually mix cable-TV coax and ham radio coax and expect a clean match — Chapter 8 covers the practical fallout.

The mismatch problem. When a transmission line's characteristic impedance doesn't match the load impedance at its far end, not all the incident power is absorbed by the load. Some is reflected back toward the source. The ratio of reflected to incident voltage is the **reflection coefficient**, Γ :

$$\Gamma = (Z_L - Z_0) / (Z_L + Z_0)$$

A perfectly matched load ($Z_L = Z_0$) gives $\Gamma = 0$ — no reflection. An open circuit gives $\Gamma = 1$ (total reflection, in phase). A short gives $\Gamma = -1$ (total reflection, inverted). Everything else falls between, and the practical consequence is what Chapter 4 covers in depth: standing waves, and the VSWR meter that reads them out as a single, useful number.

Velocity factor. A wave doesn't travel through a transmission line's dielectric at the speed of light in free space — it's slowed by the dielectric constant of the insulation, typically to 66-85% of c for common coax types (printed on the cable's datasheet as VF). This matters directly when you cut a piece of coax to an electrical quarter-wave or half-wave for a matching stub or phasing line — you must scale the free-space wavelength by the velocity factor, or the physical length will be wrong and the stub will resonate at the wrong frequency.

$$\text{Physical length} = (c / f) \times \text{VF}$$

Loss in transmission lines comes from two mechanisms: conductor (I^2R) loss, which rises with frequency because of skin effect concentrating current in a thinner layer of the conductor, and dielectric loss, which also rises with frequency as the insulating material's molecules churn more under a faster-alternating field. Both are why the same coax that's essentially lossless at HF can waste half your transmitter power over a long run at 2.4 GHz — a fact that surprises people building Wi-Fi antenna systems who reuse HF-rated cable because "it's what was in the garage."

Baluns and the Balanced-to-Unbalanced Problem

Coax is inherently **unbalanced** — the shield is at ground potential and the center conductor carries the signal referenced to it. Many antennas (a dipole being the classic case) are inherently **balanced** — neither conductor is at ground, and the two halves are meant to carry equal and opposite currents. Feed a balanced antenna directly with unbalanced coax and current flows back down the outside of the shield, turning the feedline itself into part of the radiating (and receiving) system in an uncontrolled way — distorting the antenna pattern, coupling RF into equipment connected elsewhere on that same feedline, and producing exactly the kind of "my antenna analyzer says it's fine but something's still wrong" symptom that sends people chasing the wrong fault for hours.

A **balun** (balanced-unbalanced transformer) corrects this at the feedpoint, forcing equal and opposite currents onto the two antenna terminals and choking off shield current from flowing further. Baluns come in several practical forms: **current (choke) baluns**, which work by presenting high impedance to common-mode (shield) current using ferrite cores or coiled coax, are generally preferred for their broadband, forgiving behavior; **voltage baluns**, transformer-wound designs that also often provide an impedance transformation (commonly 4:1) alongside the balanced conversion, useful when you need both functions at once but somewhat less tolerant of a poor load match than a good current balun.

A choked feedline substitutes for a formal balun in many practical installations — coiling several turns of coax near the feedpoint, or threading it through ferrite cores, presents the same high common-mode impedance a purpose-built current balun does, at near-zero cost, and is a standard field fix worth knowing when troubleshooting a balanced antenna that's showing symptoms of shield current (RF feedback into a microphone, erratic pattern behavior, a "hot" feedline you can detect by hand near the antenna while transmitting).

Bench Check

1. Why can't you calculate a transmission line's characteristic impedance from its length?
2. A load has $Z_L = 150$ ohms on a 50-ohm line. Calculate Γ . Is more or less than half the incident power reflected?
3. You need a quarter-wave stub at 146 MHz using cable with $V_F = 0.66$. What physical length do you cut?
4. Why does the same cable that works fine at HF show significant loss at 2.4 GHz?

Chapter 3: The Smith Chart in Practice

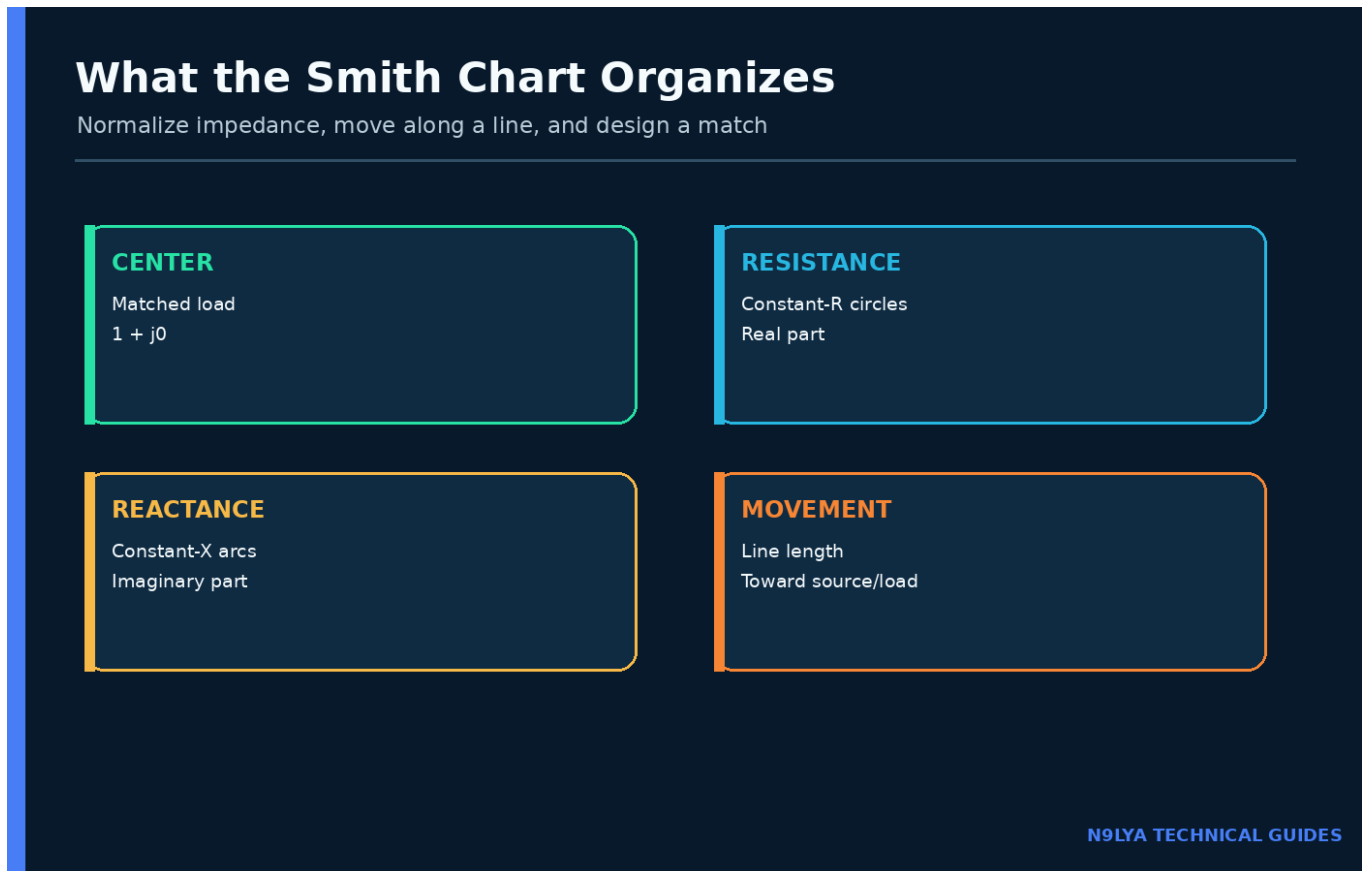


Figure 3: Smith chart organization

The Smith chart intimidates people because it's usually introduced as an abstract graphical solution to a transmission line equation, with the actual use of the thing buried three chapters later or skipped entirely. Here's the use, first: **the Smith chart is a map of every possible impedance, normalized to your system impedance, laid out so that moving along a transmission line corresponds to rotating around the chart.** Once that clicks, the chart stops being a curiosity and becomes the fastest way to solve matching problems by hand.

Normalization. Every impedance on the chart is divided by Z_0 first. A 50-ohm load on a 50-ohm system normalizes to $1 + j0$ — dead center. A 100-ohm resistive load normalizes to $2 + j0$. This is why the same chart works for 50-ohm and 75-ohm systems; you just normalize differently going in and denormalize differently coming out.

Reading the chart. The horizontal axis through the center is pure resistance, from 0 ohms (left edge, a short) to infinity (right edge, an open). Circles that pass through the right edge and get progressively smaller as they move left are constant-resistance circles. Arcs radiating from the right edge are constant-reactance curves — above the horizontal axis is inductive ($+jX$), below is capacitive

(-jX). Any point on the chart is a complex impedance, read off by finding which resistance circle and which reactance arc it sits on.

Moving along a transmission line rotates you around the chart, clockwise toward the generator, at a rate of one full revolution per half-wavelength of line. This is the single fact that makes the chart useful: if you know the load impedance and the electrical length of line between the load and where you're standing, you rotate the load's point by that many degrees around the outer wavelength scale and read off the impedance you'd actually measure at your test point — no equation-solving needed.

Worked example — a stub match. Suppose you measure a load impedance of $25 + j25$ ohms on a 50-ohm system. Normalized, that's $0.5 + j0.5$. Plot it. To match this to 50 ohms using a single shorted shunt stub, you move along the constant-VSWR circle (a circle centered on the chart's center, passing through your plotted point) until you cross the $1 + jX$ circle — the circle representing “unity conductance,” where a parallel stub of the right reactance can cancel the remaining reactance and leave you at the center. The angular distance you rotated tells you how far from the load to place the stub; the reactance value where you crossed the ‘1

- jX' circle tells you what reactance the stub itself needs to supply, which a length chart or a second pass on the Smith chart converts into a physical stub length.

That entire process — a page of algebra done with complex numbers, by hand — collapses into a few compass-and-protractor style moves on the chart. That's the payoff, and it's why the chart survived seventy-plus years of otherwise being replaced by calculators: for a huge class of practical matching problems, it's still faster than the algebra, and it gives you geometric intuition for what's happening that a closed-form answer doesn't.

Modern practice. You will do this in software most of the time — a vector network analyzer will show you a live Smith chart trace as you tune a matching network, moving in real time. But the software display means nothing if you can't read it, and being able to sanity-check a software result by eye, at a glance, is what separates someone who understands what they're looking at from someone reading a pass/fail light.

Bench Check

1. Where on the Smith chart does a perfectly matched 50-ohm load fall?
2. A load normalizes to $0.3 - j0.4$. Is it inductive or capacitive, and is its resistance above or below Z_0 ?
3. How many degrees of chart rotation corresponds to a physical half-wavelength of transmission line?
4. Why is the $1 + jX$ circle significant when designing a shunt stub match?

Chapter 4: Standing Waves and VSWR

When a mismatched load reflects some of the incident wave, the reflected wave travels back up the line and interferes with the forward wave — at some points along the line reinforcing (voltage maxima), at others cancelling (voltage minima), spaced a quarter-wavelength apart. That pattern, fixed in position along the line rather than traveling, is a **standing wave**.

VSWR (Voltage Standing Wave Ratio) compresses that pattern into one number: the ratio of the maximum voltage on the line to the minimum.

$$\text{VSWR} = (1 + |\Gamma|) / (1 - |\Gamma|)$$

A perfect match gives $\text{VSWR} = 1:1$. A total mismatch (open or short) gives $\text{VSWR} = \text{infinity}$. In practice, a well-matched antenna system runs 1.5:1 or better; most transmitters tolerate up to about 2:1 without protection circuitry cutting power; beyond that, you're wasting an increasing fraction of your power as reflected energy and risking damage to the final amplifier stage, which sees an impedance it wasn't designed to drive.

A crucial and widely misunderstood point: a high VSWR reading does not necessarily mean the antenna is radiating poorly. VSWR only tells you about the match at the point of measurement. A dummy load presents a perfect 1:1 match and radiates nothing at all. An antenna with a genuinely

poor match but that's otherwise efficient may still radiate reasonably once matched at the transmitter, though you're still wasting power in the mismatched feedline as heat, and the mismatch reflects back into the transmitter's output stage where it can matter a great deal. VSWR is a statement about impedance matching, not about radiation efficiency — the two are related but not identical, and conflating them leads to a lot of wasted troubleshooting time chasing the wrong problem.

Return loss is the same information expressed logarithmically, and it's what a network analyzer typically displays:

$$\text{Return Loss (dB)} = -20 \times \log_{10}(|\Gamma|)$$

A 1:1 VSWR is infinite return loss (no reflection at all). A 2:1 VSWR is about 9.5 dB return loss. A 1.5:1 VSWR is about 14 dB return loss. Higher return loss numbers mean a better match — it's easy to get this backward if you're used to thinking of "loss" as bad, so double-check which direction you're reading on any given instrument.

Finding the fault with standing waves. Before modern network analyzers were affordable, technicians located transmission line faults by physically probing the line for the standing wave pattern with a slotted line — an instrument with a slot cut along its length and a probe that rides along it, reading relative voltage as it travels. The spacing between minima tells you the wavelength on the line (and hence the velocity factor, if you know the frequency), and the position of a minimum relative to the load tells you the phase of the reflection, both of which are exactly the information a Smith chart calculation needs. You are very unlikely to build or use a slotted line today, but understanding what one measures is exactly the same concept a modern TDR (time-domain reflectometer, Chapter 22) exploits to find a fault's physical location along a cable — the tool changed, the physics didn't.

In-line VSWR meters — the kind found in every ham shack — work by sampling forward and reflected power with directional couplers (Chapter 5) and displaying the ratio, either as a needle deflection or a direct VSWR readout. Cheap ones are notoriously inaccurate below about 3 MHz and above about 150 MHz; if a reading looks suspicious, cross-check with a second instrument, ideally a proper return-loss bridge or a network analyzer, before condemning an antenna.

Practical Troubleshooting With a VSWR Meter

A VSWR reading by itself tells you that something's mismatched, not what or where. Building a mental checklist around the reading turns it into a genuinely diagnostic tool rather than just a pass/fail indicator.

A VSWR that's high across the entire band points toward the antenna itself — wrong length, wrong feedpoint configuration, a fundamental design or damage issue that affects the antenna's impedance broadly rather than at one specific frequency.

A VSWR that's good at the design frequency but degrades rapidly moving away from it is normal, expected antenna behavior (every antenna has finite bandwidth, Chapter 6) — not a fault at all, unless the usable bandwidth is narrower than the antenna's specification, which points toward a Q-lowering problem like corrosion increasing loss resistance, or a genuine mistuning.

A VSWR that changes when you flex or move the feedline, especially near a connector, almost always means a connector or cable fault — a cracked center pin, a partially broken shield braid, water intrusion — rather than an antenna problem at all, and is exactly the "wobble test" technique covered in Chapter 22's troubleshooting discussion.

A VSWR that reads perfectly 1:1 regardless of what you do is itself a red flag, not a good sign — it often indicates an open or a dead short very close to the meter (inside the connector, at the radio itself) rather than a genuinely well-matched system, since a truly open or shorted line reflects 100% of power back, and depending on the electrical length between the fault and the meter, that can present as an artificially clean-looking reading. Cross-check a suspiciously perfect reading with a second measurement point or instrument before trusting it.

Bench Check

1. Calculate VSWR for a load giving $|\Gamma| = 0.2$.

2. Why can a dummy load show a perfect VSWR while radiating nothing?
3. Convert a 3:1 VSWR to return loss in dB.
4. What historical instrument located transmission line faults before network analyzers, and what modern instrument uses a related principle?

Part II — Passive RF Components

Chapter 5: Filters, Couplers, and Splitters

Filters shape a signal's frequency content by passing some frequencies and attenuating others. The four basic responses — low-pass, high-pass, band-pass, and band-stop (notch) — cover the large majority of what you'll design or troubleshoot.

Key filter specifications, all of which matter more in practice than the textbook transfer function:

- **Insertion loss:** attenuation in the passband, ideally near zero, never actually zero.
- **Stopband attenuation:** how much rejection you get at a specified frequency outside the passband.
- **Bandwidth:** usually specified at the -3 dB points, where power has dropped to half.
- **Shape factor:** the ratio of a filter's bandwidth at a deep attenuation level (say -60 dB) to its -3 dB bandwidth — a measure of how sharply it transitions from passband to stopband. A shape factor near 1 is a "brick wall" filter; a shape factor of 5 or more is a gentle roll-off.
- **Group delay:** how much a filter delays different frequencies within the passband relative to each other. Ignored in casual work, critical in anything carrying wideband digital modulation, because uneven group delay distorts the signal shape even when amplitude response looks flat.

Cavity filters and helical resonators dominate at VHF/UHF where you need narrow bandwidth and high power handling — repeater duplexers are built from tuned cavities precisely because lumped-element LC filters can't achieve the required Q (selectivity) at those power levels without physically enormous, impractical components. Tuning a cavity filter by ear (literally, listening for the notch depth to bottom out while adjusting) is a real, still-practiced skill in two-way radio shops.

Directional couplers sample a small, known fraction of power flowing in one direction on a transmission line while ignoring power flowing the other way — the component that makes a VSWR meter possible, by sampling forward and reflected power separately. The key spec is **directivity**: how well the coupler rejects the wave traveling the "wrong" direction. Poor directivity is a common, underappreciated source of VSWR meter inaccuracy, because the meter is supposed to be measuring only reflected power but is actually leaking in some forward power too.

Power splitters and combiners divide a signal N ways (or combine N signals into one) while maintaining impedance match on every port. A simple resistive splitter is broadband and lossy (a two-way split costs you the theoretical 3 dB plus real resistive loss). A hybrid (Wilkinson) splitter achieves the same split with much lower loss and, critically, provides isolation between the output ports — a signal reflected back into one output port doesn't leak into the other, which matters enormously in combiner applications where you're summing multiple transmitters onto one antenna and don't want one transmitter's output stage seeing the other's signal.

Bench Check

1. What does "-3 dB bandwidth" mean, and why is that point chosen rather than, say, -1 dB or -10 dB?
2. Why can't a lumped LC filter easily achieve the selectivity of a cavity filter at 450 MHz?
3. What does a directional coupler's "directivity" spec tell you, and how does poor directivity corrupt a VSWR reading?
4. Why would you choose a Wilkinson splitter over a resistive splitter for combining two transmitters onto one antenna?

End of the free sample

Microwave and Communications Electronics — Second Edition · by Jerome M. Kutche

That was the first 11 of 44 pages. The full book continues with the practical detail, worked examples and recovery steps that don't fit in a sample.

Get the full book (\$5.99, PDF + EPUB):

<https://booksrus.biz/product/microwave-and-communications-electronics/>

Also on Gumroad:

<https://n9lya4.gumroad.com/l/bjmamc>



All 17 Second Edition guides in one bundle for \$89.99:

booksrus.biz/product/n9lya-technical-guides-complete-bundle

This sample may be shared freely in unmodified form. © Jerome M. Kutche. Second Edition.