



# Chapter 4

## Basic Test Equipment

Meters and Oscilloscopes  
Impedance and Antenna Bridges  
Field Strength and Power



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# Basic Test Equipment

- Multimeters: VOM or DMM
- Oscilloscope
- Signal Generator
- Frequency Standards and Frequency Counters
- Two-Tone Test Generator (for SSB)
- Monitor Scope
- Noise Bridge
- SWR Meters and Antenna Analyzers
- Field Strength Meter



# Test Equipment Considerations

## Precision and Accuracy

- More digits may not be more accuracy
- Calibration and Zeroing
- Useful Frequency Range
  - Readings at limits of range may be suspect
- Loading of circuit under test
  - Higher impedance input has lower effect
  - 10 Megohm for voltages; 50 Ohm for power
- Ease of use
  - Menus or knobs; Readability of display



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# Digital Multi-Meter



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# Multimeter Types

## Analog VOM

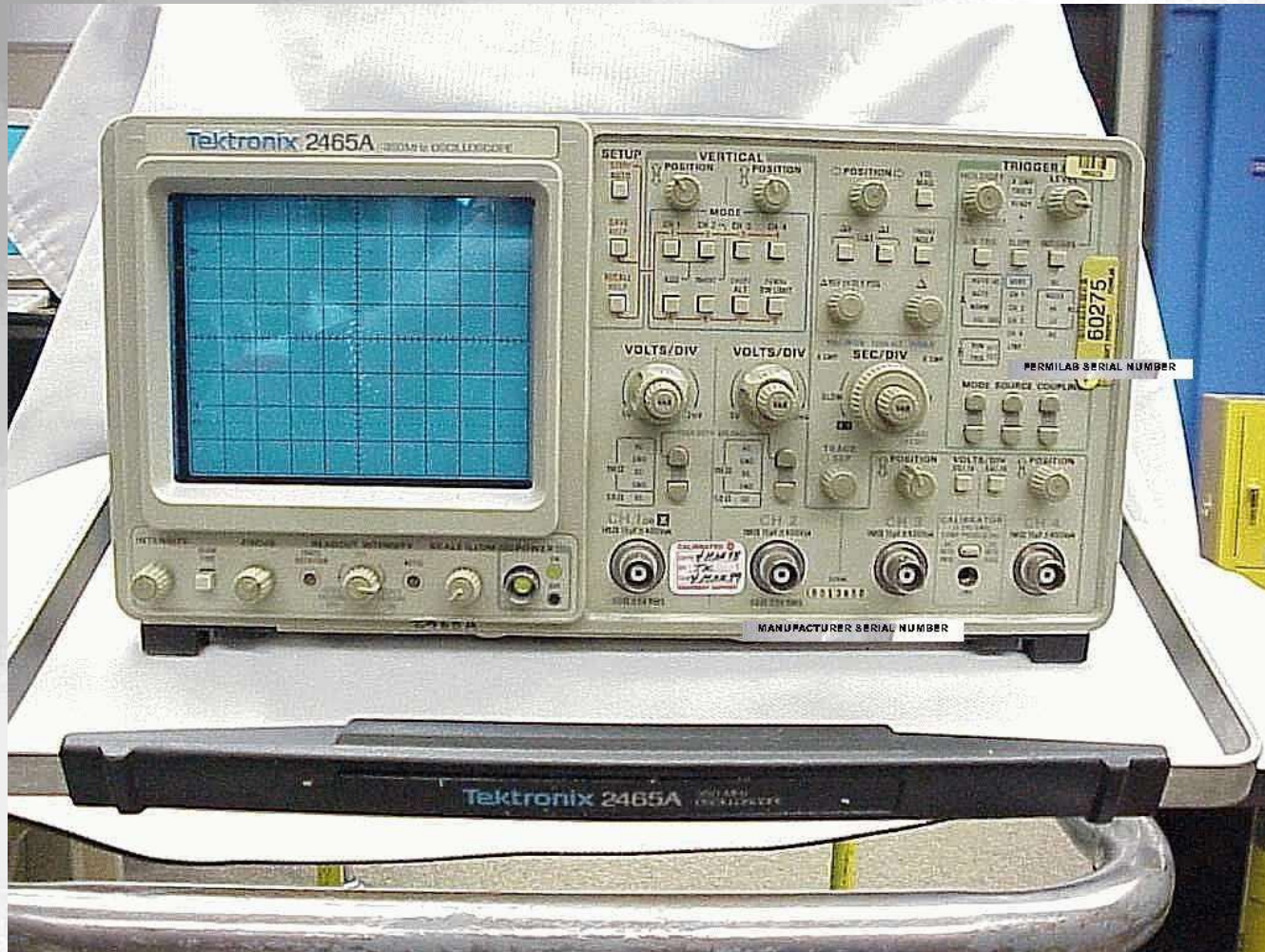
- Relatively low impedance – 50KOhms/Volt
- Analog motion can make adjustments more visible
- AC readings have frequency and distortion limits
- Digital DMM
  - High impedance – usually  $> 10\text{MegOhms}$
  - More precise readings
  - AutoRanging
  - May include Frequency, Capacitance, and Inductance
  - May include USB port for computer connection



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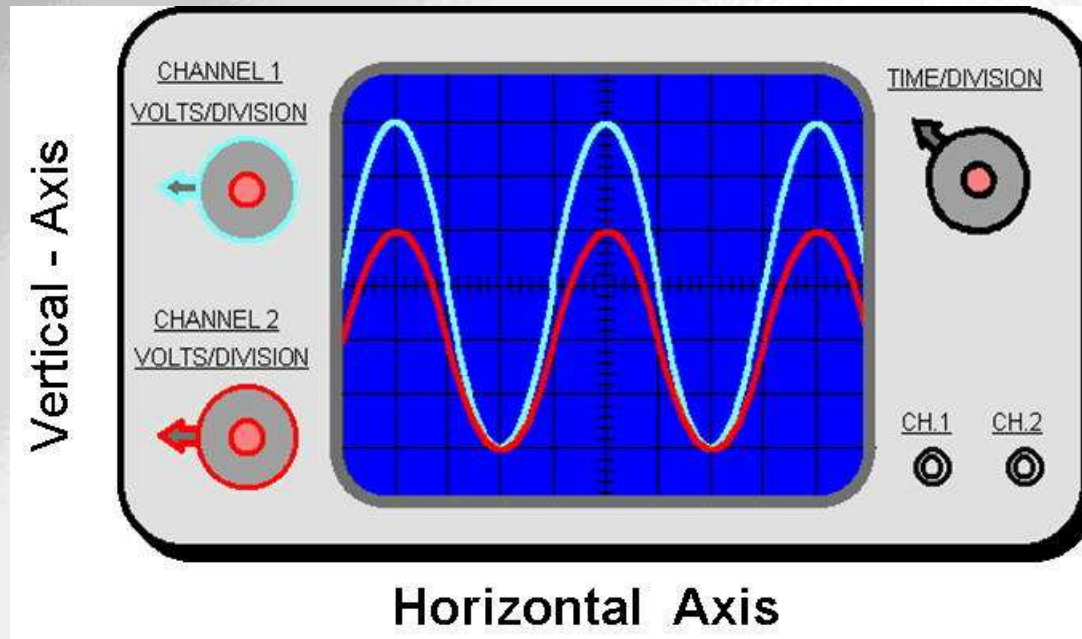
# Oscilloscope



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# Oscilloscope Features



# Oscilloscopes

Observe and measure signals in real time

- Capture fast changing waveforms
- Measure peak voltages and times
- Observe distortion and timing
- Wide bandwidth for RF measurements
  - 100 MHz bandwidth adequate for HF and 6Meters
  - Digital circuit testing may need more bandwidth
  - Bandwidth is a function of the Vertical Channels
- Two or more *traces* enable timing comparisons of waveforms



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# RF Signal Generators



# Signal Generators

## Types by waveform and frequency range

- Waveforms – Sine, Square, Triangle, Sweep
- Audio, LF, MF, HF, VHF, UHF, Microwave
- Outputs
  - Low impedance for 50 Ohm circuits
  - Calibrated levels in Microvolts or *dbm* .
  - Calibrated *attenuator*
  - Modulation
- Modern sig gens use *digital synthesizers* to generate very accurate frequencies



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# HF and VHF SWR Analyzer



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# Impedance and SWR Meters

Can be used to test an antenna and feedline without transmitting high power

- Measure SWR and impedance over a wide frequency range
- Measure or estimate feedline Z, Loss, and electrical length
- Analyzer includes a signal generator and frequency counter.
- Nearby strong transmitted signals may interfere with accurate measurements.



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# Noise Bridge

Connected between a receiver and an antenna of unknown impedance and tuned for minimum noise.

- Can determine characteristic impedance for transmission lines.
- Can be used for pre-tuning an antenna tuner.



# Field Strength Meters

Make calibrated readings of field strength

- Compare changes from adjusting antennas
- Plot radiation patterns as antenna is rotated.
- Use as a close-in indicator when searching for a transmitting source.



# SWR and Watt Meter



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# Measuring SWR and Power

Meters designed to install in feedline and measure SWR and Power while transmitting.

- Some meters have plug-ins designed to cover frequency ranges.
- *Directional Wattmeter* measures forward and reverse power.
- SWR may be calculated from  $P_{fwd}$  and  $P_{rev}$ .
- Antenna is adjusted for minimum  $P_{rev}$ .
- Transmitter is adjusted for maximum  $P_{fwd}$ .

