Antenna Analyzers
Not just for antennas anymore...

Presented by KN4FEN

Typical Analyzers

Generally around $250-$600 and higher

Model MFJ-269C

1.1 Typical Use

The MFJ-269C may be used to adjust, test, or measure the following:

Antennas:	SWR, impedance, reactance, resistance, resonant frequency, and bandwidth
Antenna tuners:	SWR, bandwidth, frequency
Amplifiers:	Input and output matching networks, chokes, suppressors, traps, and components
Coaxial transmission lines:	SWR, length, velocity factor, approximate Q and loss, resonant frequency, and impedance
Filters:	SWR, attenuation, and frequency range
Matching or tuning stubs:	SWR, approximate Q, resonant frequency, bandwidth, impedance
Traps:	Resonant frequency and approximate Q
Tuned Circuits:	Resonant frequency and approximate Q
Small capacitors:	Value and self-resonant frequency
RF chokes and inductors:	Self-resonant frequency, series resonance, and value
Transmitters and oscillators:	Frequency

In physics and engineering the quality factor or **Q factor** is a dimensionless parameter that describes how underdamped an oscillator or resonator is, and characterizes a resonator's bandwidth relative to its centre frequency. Higher Q indicates a lower rate of energy loss relative to the stored energy of the resonator; the oscillations die out more slowly. A pendulum suspended from a high-quality bearing, oscillating in air, has a high Q, while a pendulum immersed in oil has a low one. Resonators with high quality factors have low damping, so that they ring or vibrate longer.

The MFJ-269C measures and directly displays the following:

Electrical length (feet or deg)	Impedance phase angle(degrees)	Resonance (MHz)
Feedline Loss (dB)	Inductance (μH)	Return loss (dB)
Capacitance (pF)	Reactance or X (ohms)	Signal Frequency (MHz)
Impedance or Z magnitude (ohms)	Resistance or R (ohms)	SWR (Zo programmable)

Complex impedance / where **Rs** equals the load's series **resistive** component and **Xs** shows the load's series **reactive** component. (Ohms)

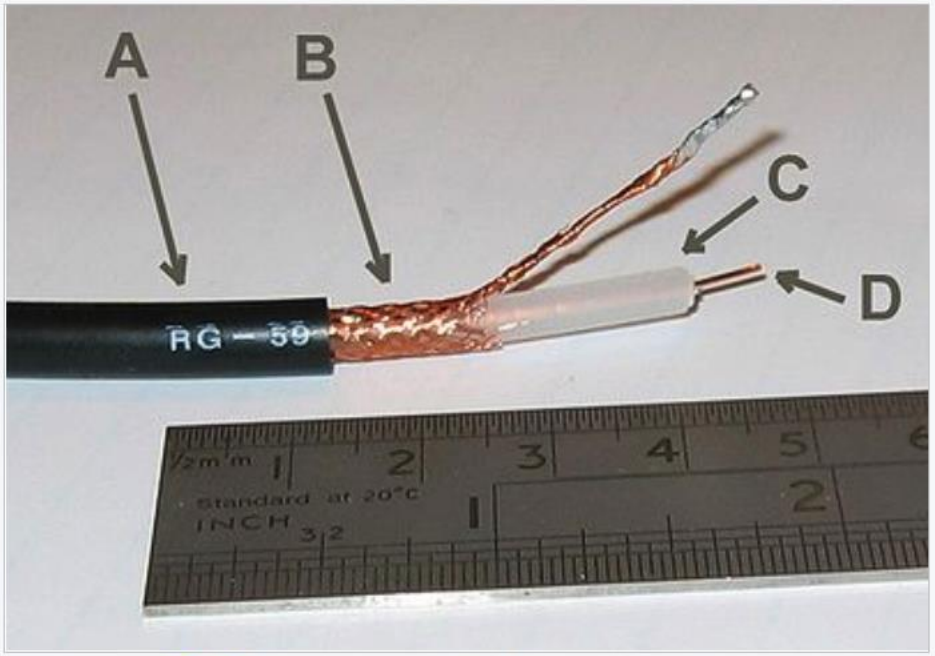
Noteworthy: Analog SWR / Impedance Meters (**Z**)

Coaxial Cable

Oliver Heaviside invented coaxial cable in 1880.

Coaxial Cable

Construction



RG-59 **flexible coaxial cable** composed of:

A. Outer plastic sheath
B. Woven copper shield
C. Inner dielectric insulator
D. Copper core

Defective Cable

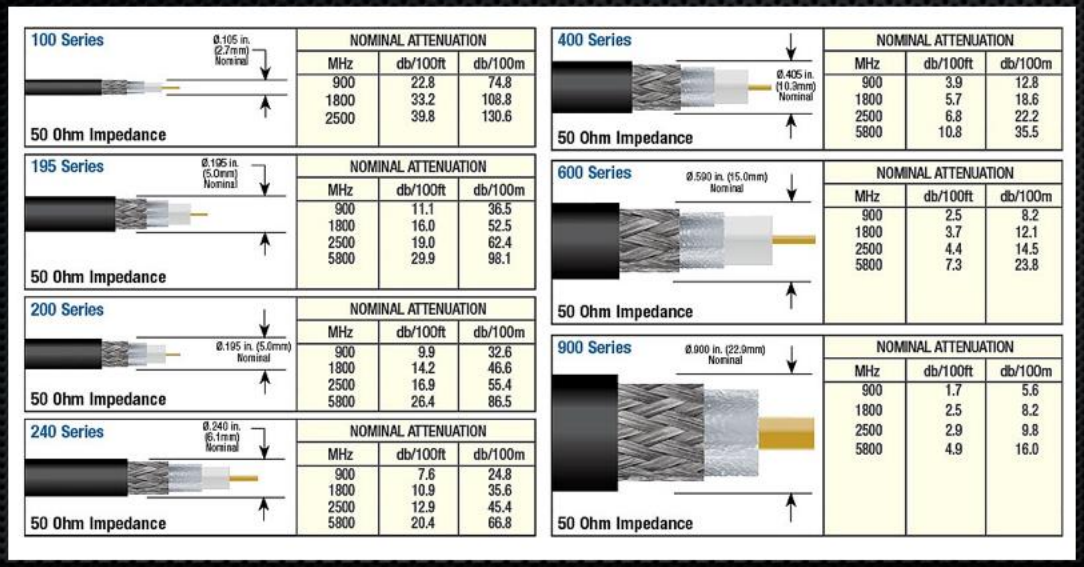
Your coax may not really be 50 ohms. Kinks, water ingress, oxidation, corrosion, bad connectors, improper manufacturing, or even mislabeling may be the cause. Check SWR with a dummy load installed at the far end of the cable. If the SWR is elevated or the Impedance (Z) fluctuates very much as you tune the analyzer's VFO, suspect a defective cable.

Coax Attenuation (dB Loss)

Lots of reasons cause “loss”, or attenuation of a signal; impedance and/or resistance.

Coaxial Cable Loss (dB)
per 100' (30.5m)
VHF, UHF, SHF

Cable Type	144 MHz	220 MHz	450 MHz	915 MHz	1.2 GHz	2.4 GHz	5.8 GHz
RG-174	10.1	12.5	18.1	26.1	30.1	na	na
RG-58	5.5	6.9	10.0	14.6	16.9	na	na
RG-8X	4.2	5.3	8.0	12.3	14.6	na	na
RG-6A (75 ohm)	3.4	4.2	6.3	9.4	11.0	16.7	na
LMR-240	3.0	3.7	5.3	7.6	8.8	12.7	na
RG214	2.7	3.4	5.0	7.5	8.8	13.3	na
RG213	2.4	3.0	4.5	6.7	7.9	12.0	na
RG-8/U	2.4	3.0	4.5	6.7	7.9	12.0	na
9913	1.6	1.9	2.8	4.2	5.2	7.7	13.8
LMR-400	1.5	1.8	2.7	3.9	4.8	6.8	10.8
LDF2 3/8"	1.3	1.6	2.3	3.4	4.2	5.9	8.1
LMR-600	0.95	1.2	1.7	2.5	3.1	4.4	7.3
LDF4 1/2"	0.88	1.0	1.5	2.1	2.5	3.6	6.0
LDF5 7/8"	0.44	0.55	0.81	1.2	1.4	2.1	3.5
LDF6 1 1/4"	0.31	0.39	0.57	0.85	1.0	1.5	2.6
LDF7 1 5/8"	0.28	0.35	0.52	0.77	0.96	1.4	2.5



100 Series — Ø.105 in. (2.7mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	22.8	74.8
1800	33.2	108.8
2500	39.8	130.6

195 Series — Ø.195 in. (5.0mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	11.1	36.5
1800	16.0	52.5
2500	19.0	62.4
5800	29.9	98.1

200 Series — Ø.195 in. (5.0mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	9.9	32.6
1800	14.2	46.6
2500	16.9	55.4
5800	26.4	86.5

240 Series — Ø.240 in. (6.1mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	7.6	24.8
1800	10.9	35.6
2500	12.9	45.4
5800	20.4	66.8

400 Series — Ø.405 in. (10.3mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	3.9	12.8
1800	5.7	18.6
2500	6.8	22.2
5800	10.8	35.5

600 Series — Ø.590 in. (15.0mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	2.5	8.2
1800	3.7	12.1
2500	4.4	14.5
5800	7.3	23.8

900 Series — Ø.900 in. (22.9mm) Nominal — 50 Ohm Impedance

NOMINAL ATTENUATION		
MHz	db/100ft	db/100m
900	1.7	5.6
1800	2.5	8.2
2500	2.9	9.8
5800	4.9	16.0

Another Loss Table Example

Higher frequencies generally increase loss.

Velocity Factor

The speed of radio signals in a vacuum is the speed of light, and so the velocity factor of a radio wave in a vacuum is unity, or 100%.

Brand:	DX Engineering
Manufacturer's Part Number:	DXE-8XDX018
Part Type:	Coaxial Cable Assemblies
Product Line:	DX Engineering RG-8X PL-259 Low-Loss 50-ohm Coax Cable Assemblies
DXE Part Number:	**DXE-8XDX018**
Coaxial Cable Type:	RG-8X
Cable Connector End 1:	PL-259
Cable Connector End 2:	PL-259
Coaxial Cable Jacket Outside Diameter:	0.242 in.
Coaxial Cable Jacket Material:	PVC, Non-contaminating, Type II-A
Center Conductor Gauge:	16 AWG
Center Conductor Material:	Bare copper
Center Conductor Construction:	19 strands of 29 AWG
Dielectric Material:	Gas injected foam polyethylene
Dielectric Outside Diameter:	0.157 in.
Shield 1 Construction:	Braided
Shield 1 Material:	Bare copper
Shield 1 Percent Coverage:	96-97
Loss Per 100 ft. at 30 MHz:	1.4 dB
Velocity Factor Percentage:	82
Coaxial Cable Length:	18 ft.
UV-Resistant:	Yes
Direct Bury:	Yes
Quantity:	Sold individually.

SWR is always your best predictor of antenna performance.

SWR
Resonance
Impedance

It's always preferable to measure SWR rather than resonance or impedance magnitude (Z) as the standard for adjusting your antenna.

By definition, minimum SWR (1:1) and maximum power transfer occur when the source, transmission line, and load impedance are all of equal value (conjugate match).

SWR is always your best predictor of antenna performance.

SWR
Resonance
Impedance

If your antenna doesn't happen to present a 50-ohm load at resonance, there will still be resistive mismatch (and SWR) in the system. In fact, slightly lower SWR may actually occur on some other frequency. By the same token, if you adjust your antenna for an Impedance reading of 50 ohms, it may have a substantial reactive component (for example R = 46, X = 17) that would elevate SWR and shift the minimum-SWR point to a different frequency.