

High Power RF Cables & Assemblies



T **TIMES** MICROWAVE SYSTEMS

- ***Magnetic Resonance Imaging***
- ***Semi-Conductor Manufacturing***
- ***Physics Research***
- ***High Power Lasers***
- ***Pulse Power***
- ***High Power Radar***



High Power Coaxial Cable and Assemblies

This brochure provides technical information for selecting the best coaxial cable solution for high power RF applications, including magnetic resonance imaging (MRI), semi-conductor manufacturing equipment, nuclear physics research, high power lasers and radar.

Although Times Microwave Systems may be better known for providing precision cable assemblies for microwave applications up to 40 GHz and higher, we have also been the leading provider of cables and assemblies for applications below 100 MHz and powers as high as 50 kW. Our broad range of manufacturing capabilities enables us to offer rugged, flexible cables and cable assemblies, that can operate in high ambient temperatures and provide environmental resistance, while handling both high average and peak powers. Constructions are available to meet requirements for low loss, high RF shielding, and low VSWR.

Since each application requires a different set of performance characteristics, having a wide range of cables to choose from allows the trade-offs to be considered and the best cable for the application to be chosen. We produce cables with dielectrics of solid PE and PTFE, foam PE and expanded PTFE; outer conductors of round wire, flat wire and composite constructions; and jackets of PE, FEP, PVC, Urethane, Nomex, Kapton and other materials.

Connector Selection

At the relatively low frequencies and high powers typically encountered in these applications, considerations for the best interface selection are very different than in microwave



applications. Impedance uniformity through the interface is not as critical, but high contact forces, low contact resistance and a large interface diameter are very important. From a performance point of view, EIA flange connectors are the ideal choice with their bolt-together outer contacts and inside spring finger center-contacts. Their disadvantages include large size, high cost and time-consuming installation. Other good choices include LC's and 7/16 DIN's. Frequently, the equipment being connected to dictates the interface. Some interfaces that Times Microwave Systems provide include:

- N male
- HN male
- 7/16 DIN male
- 7/8" EIA flange
- QDS
- LC male
- Other connectors

Cable Assemblies

Our capability to manufacture cables and connectors and our expertise in assembling and testing them enable us to design cable assemblies for your applications. We produce cable assemblies for use at continuous operating temperatures as high as 250°C, as well as electrical ratings up to a peak power of 39,000 kW and DC voltage to withstand 125 kV. Built to exacting standards, we design our cable assemblies for reliability in the most hostile environments. Assemblies can be matched in phase length or supplied in specific electrical lengths with customer required markings added. Complete test data on VSWR, insertion loss, corona and other parameters is available.

About Times Microwave Systems

Times Microwave Systems designs and manufactures high performance coaxial cables, connectors and cable assemblies for a broad range of RF and microwave transmission applications. With a heritage of more than 50 years, Times is the leader in the development of new and innovative cable products to meet the demands of evolving RF and microwave applications.

Company Philosophy

Unlike other cable manufacturers with limited product lines, who try to fit customer applications into their existing products, the philosophy of Times is to select or design the right product for each application. Times applies its expertise to customer requirements through a staff of field application engineers, who are ready to serve your specific needs.

High Power Cable

	RG-177	RG-217	RG-218	RG-220 Single Shield	RG-220 Double Shield	RG-220 Triple Shield	RG-220 FERMI	
Attenuation: dB/100ft (/100m) @								
13.56 MHz	0.29 (0.950)	0.48 (1.590)	0.27 (0.890)	0.20 (0.660)	0.20 (0.660)	0.20 (0.660)	0.19 (0.620)	
50 MHz	0.59 (1.92)	0.96 (3.15)	0.55 (1.81)	0.42 (1.37)	0.42 (1.37)	0.42 (1.37)	0.39 (1.29)	
100 MHz	0.87 (2.8)	1.40 (4.6)	0.82 (2.7)	0.63 (2.1)	0.63 (2.1)	0.63 (2.1)	0.59 (1.9)	
1000 MHz	3.60 (11.8)	5.28 (17.3)	3.44 (11.3)	2.84 (9.3)	2.84 (9.3)	2.84 (9.3)	2.74 (9.0)	
1500 MHz	4.76 (15.6)	6.81 (22.3)	4.56 (15.0)	3.83 (12.6)	3.83 (12.6)	3.83 (12.6)	3.70 (12.1)	
K1	0.07400 (0.24279)	0.12700 (0.41669)	0.06900 (0.22639)	0.05000 (0.16405)	0.05000 (0.16405)	0.05000 (0.16405)	0.04667 (0.15312)	
K2	0.00126 (0.00413)	0.00126 (0.00413)	0.00126 (0.00413)	0.00126 (0.00413)	0.00126 (0.00413)	0.00126 (0.00413)	0.00126 (0.00413)	
CW Power (kW) @								
13.56 MHz	10	5	11	16	16	16	17	
50 MHz	4.9	2.3	5.3	7.8	7.8	7.8	8.3	
100 MHz	3.3	1.6	3.6	5.2	5.2	5.2	5.5	
1000 MHz	0.8	0.4	0.8	1.1	1.1	1.1	1.2	
1500 MHz	0.6	0.3	0.6	0.8	0.8	0.8	0.9	
Peak Power (kW)	22,000	6,000	22,000	39,000	39,000	39,000	39,000	
DC Voltage (kV)								
	95	50	95	125	125	125	125	
DC Resistance ohms/1000ft (/km):								
center conductor	0.273 (0.896)	0.923 (3.028)	0.273 (0.896)	0.153 (0.502)	0.153 (0.502)	0.153 (0.502)	0.153 (0.502)	
outer conductor	0.303 (0.994)	0.600 (1.969)	0.347 (1.139)	0.270 (0.886)	0.136 (0.446)	0.091 (0.299)	0.227 (0.745)	
~ Equivalent AWG:								
center conductor	4	10	4	2	2	2	2	
outer conductor	5	8	5	4	1	0	4	
Impedance (ohms)								
	50	50	50	50	50	50	50	
Capacitance pF/ft (/m)								
	30.8 (101.1)	30.8 (101.1)	30.8 (101.1)	30.8 (101.1)	30.8 (101.1)	30.8 (101.1)	30.8 (101.1)	
Velocity of Propagation (%)								
	65.9	65.9	65.9	65.9	65.9	65.9	65.9	
Dielectric Constant								
	2.30	2.30	2.30	2.30	2.30	2.30	2.30	
Jacket Material								
	PVC	PVC	PVC	PVC	PVC	PVC	PVC	
Jacket Dimensions: inches (mm)								
	0.895 (22.7)	0.545 (13.8)	0.870 (22.1)	1.120 (28.4)	1.165 (29.6)	1.200 (30.5)	1.180 (30.0)	
Operating Temp Range: °F (°C)								
	-40° to +176° (-40° to +80°)						-67° to +392°	
Bend Radius: inches (mm)								
	9 (229)	5.5 (140)	9 (229)	12 (305)	12 (305)	12 (305)	12 (305)	
Weight: lbs/ft (kg/m)								
	0.47 (0.70)	0.23 (0.34)	0.46 (0.69)	0.82 (1.22)	0.89 (1.33)	1.05 (1.56)	0.82 (1.22)	

Properties

RG-393	AA-5885	AA-9021 HP-226	AA-9083 HP-600	AA-9104 HP-700	AA-9007 MT-650	LMR®-400 LLPL®	LMR®-500 LLPL®	LMR®-600 LLPL®	LMR®-900 LLPL®	LMR® LLPL®
0.72 (2.361)	0.41 (1.345)	0.56 (1.825)	0.37 (1.223)	0.25 (0.825)	0.31 (1.024)	0.48 (1.567)	0.37 (1.218)	0.30 (0.990)	0.21 (0.699)	0.16 (0.512)
1.41 (4.63)	0.79 (2.60)	1.10 (3.60)	0.74 (2.44)	0.49 (1.60)	0.60 (1.98)	0.92 (3.02)	0.72 (2.35)	0.58 (1.91)	0.41 (1.36)	0.30 (1.00)
2.03 (6.7)	1.12 (3.7)	1.58 (5.2)	1.09 (3.6)	0.69 (2.3)	0.86 (2.8)	1.31 (4.3)	1.02 (3.3)	0.83 (2.7)	0.59 (1.9)	0.44 (1.4)
7.24 (23.8)	3.67 (12.0)	5.81 (19.1)	4.24 (13.9)	2.31 (7.6)	2.84 (9.3)	4.23 (13.9)	3.32 (10.9)	2.72 (8.9)	1.99 (6.5)	1.50 (4.9)
9.20 (30.2)	4.54 (14.9)	7.44 (24.4)	5.51 (18.1)	2.88 (9.4)	3.53 (11.6)	5.23 (17.1)	4.11 (13.5)	3.38 (11.1)	2.49 (8.2)	1.89 (6.2)
0.19100 (0.62667)	0.11070 (0.36321)	0.14676 (0.48152)	0.09693 (0.31803)	0.06767 (0.22203)	0.08410 (0.27593)	0.12914 (0.42371)	0.10026 (0.32895)	0.08139 (0.26704)	0.05722 (0.18774)	0.04172 (0.13688)
0.00120 (0.00394)	0.00017 (0.00056)	0.00117 (0.00384)	0.00117 (0.00384)	0.00017 (0.00056)	0.00018 (0.00059)	0.00015 (0.00048)	0.00015 (0.00048)	0.00015 (0.00048)	0.00018 (0.00059)	0.00018 (0.00059)

Loss at other Frequencies = $[K1 \times \sqrt{F}] + [K2 \times F]$ F = Frequency in MHz

12	14	18	30	45	33	5	7	10	20	35
6.4	7.4	9.3	14.8	23.2	16.8	2.6	3.9	5.4	10.2	18.0
4.4	5.2	6.4	10.1	16.3	11.8	1.8	2.7	3.8	7.1	12.6
1.2	1.6	1.7	2.6	4.9	3.6	0.6	0.8	1.1	2.1	3.6
1.0	1.3	1.3	2.0	3.9	2.9	0.5	0.7	0.9	1.7	2.9
2,200	22	6,000	9,000	62	40	16	22	40	82	90

30	3	50	62	5	4	2.5	3	4	5	9
1.550 (5.086)	0.643 (2.110)	0.860 (2.822)	0.760 (2.494)	0.410 (1.345)	0.656 (2.152)	1.800 (5.906)	1.090 (3.576)	0.730 (2.395)	0.730 (2.395)	0.730 (2.395)
1.310 (4.298)	1.140 (3.740)	0.890 (2.920)	0.850 (2.789)	0.249 (0.817)	0.697 (2.287)	1.650 (5.414)	1.270 (4.167)	1.200 (3.937)	1.200 (3.937)	1.200 (3.937)
12	8	9	9	6	8	12.5	10.5	9	9	9
11	10.5	9	9	4	8	12	11	11	11	11

50	50	50	50	50	50	50	50	50	50	50
29.3 (96.1)	25.0 (82.0)	28.6 (93.8)	28.6 (93.8)	24.8 (81.4)	25.4 (83.3)	26.7 (87.6)	26.7 (87.6)	26.7 (87.6)	26.7 (87.6)	26.7 (87.6)
69.5	80	71	71	82	78	76	76	76	76	76
2.07	1.56	1.98	1.98	1.49	1.64	1.73	1.73	1.73	1.73	1.73
FEP	FEP	FEP	FEP	ALKP/NMX	FEP/NMX	FRPVC	FRPVC	FRPVC	FRPVC	FRPVC
0.390 (9.9)	0.485 (12.3)	0.485 (12.3)	0.590 (15.0)	0.688 (17.5)	0.650 (16.5)	0.405 (10.3)	0.500 (12.7)	0.590 (15.0)	0.870 (22.1)	1.200 (30.5)

(-55° to +200°)	-67° to +392° (-55° to +200°)		-85° to +482° (-65° to +250°)		-67° to +392° (-55° to +200°)		+23° to +167° (-5° to +75°)			
4 (102)	5 (127)	5 (127)	6 (152)	6 (152)	4 (102)	2 (51)	2.5 (64)	3 (76)	4.5 (114)	6 (152)
0.17 (0.25)	0.24 (0.35)	0.24 (0.35)	0.33 (0.48)	0.40 (0.60)	0.36 (0.54)	0.11 (0.17)	0.19 (0.29)	0.24 (0.36)	0.62 (0.92)	0.70 (1.04)

-1200-	FBT-400	FBT-500	FBT-600	LMR®-600	LMR®-900	LMR®-1200
						Attenuation: dB/100ft (/100m) @
0.48 (1.567)	0.37 (1.218)	0.30 (0.990)	0.28 (0.924)	0.19 (0.633)	0.14 (0.459)	13.56 MHz
0.92 (3.02)	0.72 (2.35)	0.58 (1.91)	0.55 (1.80)	0.37 (1.23)	0.27 (0.89)	50 MHz
1.31 (4.3)	1.02 (3.3)	0.83 (2.7)	0.78 (2.6)	0.53 (1.8)	0.39 (1.3)	100 MHz
4.23 (13.9)	3.32 (10.9)	2.72 (8.9)	2.65 (8.7)	1.80 (5.9)	1.34 (4.4)	1000 MHz
5.23 (17.1)	4.11 (13.5)	3.38 (11.1)	3.32 (10.9)	2.25 (7.4)	1.69 (5.5)	1500 MHz
0.12914 (0.42371)	0.10026 (0.32895)	0.08139 (0.26704)	0.07555 (0.24788)	0.051737 (0.16986)	0.03737 (0.12261)	
0.00015 (0.00048)	0.00015 (0.00048)	0.00015 (0.00048)	0.00026 (0.00085)	0.00025 (0.00052)	0.00016 (0.00052)	
						CW Power (kW) @
9	13	17	8	13	19	13.56 MHz
4.5	6.5	8.8	4.2	6.9	9.7	50 MHz
3.2	4.6	6.2	3.0	4.8	6.8	100 MHz
1.0	1.4	1.9	0.9	1.4	2.0	1000 MHz
0.8	1.1	1.5	0.7	1.1	1.6	1500 MHz
16	22	40	40	62	90	Peak Power (kW)
						DC Voltage (kV)
2.5	3	4	4	5	6	
						DC Resistance: ohms/1000ft (/km):
						center conductor
1.800 (5.906)	1.090 (3.576)	0.730 (2.395)	0.530 (1.739)	0.540 (1.772)	0.320 (1.050)	
						outer conductor
1.650 (5.414)	1.270 (4.167)	1.200 (3.937)	1.200 (3.937)	0.550 (1.805)	0.370 (1.214)	
						~ Equivalent AWG:
						center conductor
12.5	10.5	9	7	7	6	
						outer conductor
12	11	11	11	7	6	
						Impedance (ohms)
50	50	50	50	50	50	
						Capacitance pF/ft (/m)
26.7 (87.6)	26.7 (87.6)	26.7 (87.6)	23.4 (76.8)	23.4 (76.8)	23.1 (75.8)	
						Velocity of Propagation (%)
76	76	76	87	87	88	
						Dielectric Constant
1.73	1.73	1.73	1.32	1.32	1.29	
						Jacket Material
FEP	FEP	FEP	PE	PE	PE	
						Jacket Dimensions: inches (mm)
0.370 (9.40)	0.465 (11.8)	0.565 (14.4)	0.590 (15.0)	0.870 (22.1)	1.120 (28.4)	
-67° to +302° (-55° to +150°)			-40° to +175° (-40° to +85°)			Operating Temp Range: °F (°C)
						Bend Radius: inches (mm)
2 (51)	2.5 (64)	6 (152)	1.5 (38)	3 (76)	6.5 (165)	
						Weight: lbs/ft (kg/m)
0.10 (0.15)	0.17 (0.25)	0.21 (0.31)	0.13 (0.20)	0.27 (0.40)	0.45 (0.67)	

Notes:

- 1) power based on 1:1 vswr, sea level, +40°C ambient
- 2) shields in parallel for Rdc
- 3) power values are approximations, generally conservative and based on the cable's heat transfer properties
- 4) BC = bare copper
TC = tinned copper
SC = silver plated copper
ALT= aluminum tape
PE = solid polyethylene
PTFE = solid polytetrafluoroethylene
LDTFE = low density PTFE
TTFE= taped polytetrafluoroethylene
FPE = foam polyethylene
PVC = polyvinyl chloride
FEP = fluorinated ethylene propylene
FRPVC = fire retardant PVC
PE = polyethylene
ALKP = aluminum-kapton tapes
FEP/NMX = braided nomex over FEP
- 5) ~ Equivalent (copper) AWG based on DC Resistance

Our Mission

TIMES MICROWAVE SYSTEMS designs and manufactures high performance RF and microwave transmission lines. These products consist of flexible coaxial cables, connectors, accessories and cable assemblies.

We are committed to understanding the needs and requirements of our customers and providing highly engineered, cost effective products. TIMES MICROWAVE SYSTEMS is dedicated to *total* customer satisfaction and superior results for our shareholders in all we do.



TIMES MICROWAVE SYSTEMS - THE COAX LEADER

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