
Appendix A. Additional Considerations for Determining Ring Size Limits

This appendix has three purposes. First, it provides a complete set of drive distance tables in both meters and feet to use according to the instructions in Chapter 2. Second, it provides information about planning rings using 8218s and 8219s as well as rings that contain both 8228s and 8230s. Finally, if you cannot stay within all of the cabling assumptions and planning guidelines in Chapter 2 or the second section of Appendix A, the information in this appendix will help ensure that you have planned a ring that is functional. The appendix is divided into the following sections:

- Additional tables for calculating drive distance
- Planning 4 Mbps rings using 8218s and 8219s
- Planning 4 Mbps rings containing 8228s, 8220s, and 8230s
- Planning 16 Mbps rings containing 8228s, 8220s, and 8230s
- Single-wiring-closet rings with lobes longer than 100 meters
- Adjustments for undercarpet (type 8) cabling
- Adjustments for excess patch cable (type 6) length
- Adjustments for additional patch cables in the ring
- Adjustments for replacing type 1 or 2 cable with type 6 cable
- Calculations for substituting types 6 and 8 cable
- Using surge suppressors with the IBM Token-Ring Network
- Optimizing drive distances between repeaters
- Using 8220s as copper repeaters
- Using 8218s.

Additional Tables for Calculating Drive Distance

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	1263									
	2	1246	1213								
	3	1230	1197	1181							
	4	1213	1181	1164	1148						
	5	1197	1164	1148	1131	1115					
	6	1181	1148	1131	1115	1099	1082				
	7	1164	1131	1115	1099	1082	1066	1049			
	8	1148	1115	1099	1082	1066	1049	1033	1017		
	9	1131	1099	1082	1066	1049	1033	1017	1000	984	
	10	1115	1082	1066	1049	1033	1017	1000	984	967	951
	11	1099	1066	1049	1033	1017	1000	984	967	951	935
	12	1082	1049	1033	1017	1000	984	967	951	935	918
	13		1033	1017	1000	984	967	951	935	918	902
	14		1017	1000	984	967	951	935	918	902	885
	15		1000	984	967	951	935	918	902	885	869
	16		984	967	951	935	918	902	885	869	853
	17		967	951	935	918	902	885	869	853	836
	18		951	935	918	902	885	869	853	836	820
	19		935	918	902	885	869	853	836	820	803
	20		918	902	885	869	853	836	820	803	787
	21		902	885	869	853	836	820	803	787	770
	22		885	869	853	836	820	803	787	770	754
	23		869	853	836	820	803	787	770	754	738
	24		853	836	820	803	787	770	754	738	721
	25			820	803	787	770	754	738	721	705
	26			803	787	770	754	738	721	705	688
	27			787	770	754	738	721	705	688	672
	28			770	754	738	721	705	688	672	656
	29			754	738	721	705	688	672	656	639
	30			738	721	705	688	672	656	639	623
	31			721	705	688	672	656	639	623	606
	32			705	688	672	656	639	623	606	590
	33			688	672	656	639	623	606	590	574

Figure A-1. Single-Wiring-Closet Lobe Lengths in Feet (Type 1 or 2 Cable) for 4 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	385									
	2	380	370								
	3	375	365	360							
	4	370	360	355	350						
	5	365	355	350	345	340					
	6	360	350	345	340	335	330				
	7	355	345	340	335	330	325	320			
	8	350	340	335	330	325	320	315	310		
	9	345	335	330	325	320	315	310	305	300	
	10	340	330	325	320	315	310	305	300	295	290
	11	335	325	320	315	310	305	300	295	290	285
	12	330	320	315	310	305	300	295	290	285	280
	13		315	310	305	300	295	290	285	280	275
	14		310	305	300	295	290	285	280	275	270
	15		305	300	295	290	285	280	275	270	265
	16		300	295	290	285	280	275	270	265	260
	17		295	290	285	280	275	270	265	260	255
	18		290	285	280	275	270	265	260	255	250
	19		285	280	275	270	265	260	255	250	245
	20		280	275	270	265	260	255	250	245	240
	21		275	270	265	260	255	250	245	240	235
	22		270	265	260	255	250	245	240	235	230
	23		265	260	255	250	245	240	235	230	225
	24		260	255	250	245	240	235	230	225	220
	25			250	245	240	235	230	225	220	215
	26			245	240	235	230	225	220	215	210
	27			240	235	230	225	220	215	210	205
	28			235	230	225	220	215	210	205	200
	29			230	225	220	215	210	205	200	195
	30			225	220	215	210	205	200	195	190
	31			220	215	210	205	200	195	190	185
	32			215	210	205	200	195	190	185	180
	33			210	205	200	195	190	185	180	175

Figure A-2. Single-Wiring-Closet Lobe Lengths in Meters (Type 1 or 2 Cable) for 4 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	842									
	2	831	809								
	3	820	798	787							
	4	809	787	776	765						
	5	798	776	765	754	743					
	6	787	765	754	743	732	721				
	7	776	754	743	732	721	710	699			
	8	765	743	732	721	710	699	689	678		
	9	754	732	721	710	699	689	678	667	656	
	10	743	721	710	699	689	678	667	656	645	634
	11	732	710	699	689	678	667	656	645	634	623
	12	721	699	689	678	667	656	645	634	623	612
	13		689	678	667	656	645	634	623	612	601
	14		678	667	656	645	634	623	612	601	590
	15		667	656	645	634	623	612	601	590	579
	16		656	645	634	623	612	601	590	579	568
	17		645	634	623	612	601	590	579	568	557
	18		634	623	612	601	590	579	568	557	546
	19		623	612	601	590	579	568	557	546	535
	20		612	601	590	579	568	557	546	535	524
	21		601	590	579	568	557	546	535	524	514
	22		590	579	568	557	546	535	524	514	503
	23		579	568	557	546	535	524	514	503	492
	24		568	557	546	535	524	514	503	492	481
	25			546	535	524	514	503	492	481	470
	26			535	524	514	503	492	481	470	459
	27			524	514	503	492	481	470	459	448
	28			514	503	492	481	470	459	448	437
	29			503	492	481	470	459	448	437	426
	30			492	481	470	459	448	437	426	415
	31			481	470	459	448	437	426	415	404
	32			470	459	448	437	426	415	404	393
	33			459	448	437	426	415	404	393	382

Figure A-3. Single-Wiring-Closet Lobe Lengths in Feet (Type 9 Cable Only) for 4 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 82288	1	256									
	2	253	246								
	3	250	243	240							
	4	246	240	236	233						
	5	243	236	233	230	226					
	6	240	233	230	226	223	220				
	7	236	230	226	223	220	216	213			
	8	233	226	223	220	216	213	210	206		
	9	230	223	220	216	213	210	206	203	200	
	10	226	220	216	213	210	206	203	200	196	193
	11	223	216	213	210	206	203	200	196	193	190
	12	220	213	210	206	203	200	196	193	190	186
	13		210	206	203	200	196	193	190	186	183
	14		206	203	200	196	193	190	186	183	180
	15		203	200	196	193	190	186	183	180	176
	16		200	196	193	190	186	183	180	176	173
	17		196	193	190	186	183	180	176	173	170
	18		193	190	186	183	180	176	173	170	166
	19		190	186	183	180	176	173	170	166	163
	20		186	183	180	176	173	170	166	163	160
	21		183	180	176	173	170	166	163	160	156
	22		180	176	173	170	166	163	160	156	153
	23		176	173	170	166	163	160	156	153	150
	24		173	170	166	163	160	156	153	150	146
	25			166	163	160	156	153	150	146	143
	26			163	160	156	153	150	146	143	140
	27			160	156	153	150	146	143	140	136
	28			156	153	150	146	143	140	136	133
	29			153	150	146	143	140	136	133	130
	30			150	146	143	140	136	133	130	126
	31			146	143	140	136	133	130	126	123
	32			143	140	136	133	130	126	123	120
	33			140	136	133	130	126	123	120	116

Figure A-4. Single-Wiring-Closet Lobe Lengths in Meters (Type 9 Cable Only) for 4 Mbps Rings

NUMBER OF RACKS

	1	2	3	4	5	6	7	8	9	10
1	569									
2	556	523								
3	543	511	494							
4	531	498	481	465						
5	518	485	469	452	436					
6	505	472	456	439	423	407				
7	492	459	443	427	410	394	377			
8	479	447	430	414	397	381	365	348		
9	467	434	417	401	385	368	352	335	319	
10	454	421	405	388	372	355	339	323	306	290
11	441	408	392	377	359	343	326	310	293	277
12	428	395	379	363	346	330	313	297	281	264
13		383	366	350	333	317	301	284	268	251
14		370	353	337	321	304	288	271	255	239
15		357	341	324	308	291	275	259	242	226
16		344	328	311	295	279	262	246	229	213
17		331	315	299	282	266	249	233	217	200
18		319	302	286	269	253	237	220	204	187
19		306	290	273	257	240	224	207	191	175
20		279	263	247	230	214	197	181	165	148
21		253	236	220	204	187	171	154	138	122
22		226	210	193	177	161	144	128	111	95
23		200	183	167	150	134	118	101	85	68
24		173	157	140	124	107	91	75	58	42
25			130	114	97	81	64	48	32	15
26			103	87	71	54	38	21	-	-
27			77	60	44	28	11	-	-	-
28			50	34	18	-	-	-	-	-
29			24	-	-	-	-	-	-	-

Figure A-5. Single-Wiring-Closet Lobe Lengths in Feet (Type 1 or 2 Cable) for 16 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	173									
	2	170	160								
	3	166	156	151							
	4	162	152	147	142						
	5	158	148	143	138	133					
	6	154	144	139	134	129	124				
	7	150	140	135	130	125	120	115			
	8	146	136	131	126	121	116	111	106		
	9	142	132	127	122	117	112	107	102	97	
	10	138	128	123	118	113	108	103	98	93	88
	11	134	124	119	114	109	104	99	94	89	84
	12	131	121	116	111	106	101	96	91	86	81
	13		117	112	107	102	97	92	87	82	77
	14		113	108	103	98	93	88	83	78	73
	15		109	104	99	94	89	84	79	74	69
	16		105	100	95	90	85	80	75	70	65
	17		101	96	91	86	81	76	71	66	61
	18		97	93	87	83	77	72	67	62	57
	19		93	88	83	78	73	68	63	58	53
	20		85	80	75	70	65	60	55	50	45
	21		77	72	67	62	57	52	47	42	37
	22		69	65	59	54	49	44	39	34	29
	23		61	56	51	46	41	36	31	26	21
	24		53	48	43	38	33	28	23	18	13
	25			40	35	30	25	20	15	10	5
	26			32	27	22	17	12	7	-	-
	27			23	18	13	8	3	-	-	-
	28			15	10	5	-	-	-	-	-
	29			7	-	-	-	-	-	-	-

Figure A-6. Single-Wiring-Closet Lobe Lengths in Meters (Type 1 or 2 Cable) for 16 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	379									
	2	371	349								
	3	362	340	329							
	4	354	332	321	310						
	5	345	323	312	301	291					
	6	337	315	304	293	282	271				
	7	328	306	295	284	273	263	252			
	8	320	298	287	276	265	254	243	232		
	9	311	289	278	267	256	245	235	224	213	
	10	303	281	270	259	248	237	226	215	204	193
	11	294	272	261	250	239	228	217	207	196	185
	12	286	264	253	242	231	220	209	198	187	176
	13		255	244	233	222	211	200	190	179	168
	14		247	236	225	214	203	192	181	170	159
	15		238	227	216	205	194	183	172	162	151
	16		230	219	208	197	186	175	164	153	142
	17		221	210	199	188	177	166	155	144	134
	18		212	202	191	180	169	158	147	136	125
	19		204	193	182	171	160	149	138	127	116
	20		186	175	164	153	142	132	121	110	99
	21		169	158	147	136	125	114	103	92	81
	22		151	140	129	118	107	96	85	74	63
	23		133	122	111	100	89	78	67	57	46
	24		115	104	93	83	72	61	50	39	28
	25			87	76	65	54	43	32	21	10
	26			69	58	47	36	25	14	-	-
	27			51	40	29	18	-	-	-	-
	28			34	23	12	-	-	-	-	-
	29			16	-	-	-	-	-	-	-

Figure A-7. Single-Wiring-Closet Lobe Lengths in Feet (Type 9 Cable) for 16 Mbps Rings

		NUMBER OF RACKS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	116									
	2	113	106								
	3	110	104	100							
	4	108	101	98	94						
	5	105	99	95	92	89					
	6	103	96	93	89	86	83				
	7	100	93	90	87	83	80	77			
	8	97	91	87	84	81	77	74	71		
	9	95	88	85	81	78	75	71	68	65	
	10	92	86	82	79	76	74	69	66	62	59
	11	90	83	80	76	73	70	66	63	60	56
	12	87	80	77	74	70	67	64	60	57	54
	13		78	74	71	68	64	61	58	54	51
	14		75	72	68	65	62	58	55	52	48
	15		73	69	66	63	59	56	53	49	46
	16		70	67	63	60	57	53	50	47	43
	17		67	64	61	57	54	51	47	44	41
	18		65	61	58	55	51	48	45	41	38
	19		62	59	55	52	49	45	42	39	35
	20		57	53	50	47	43	40	37	33	30
	21		51	48	45	41	38	35	31	28	25
	22		46	43	39	36	33	29	26	23	19
	23		41	37	34	31	27	24	21	17	14
	24		35	32	28	25	22	18	15	12	8
	25			26	23	20	16	13	10	6	3
	26			21	18	14	11	8	4	-	-
	27			16	12	9	6	-	-	-	-
	28			10	7	4	-	-	-	-	-
	29			5	-	-	-	-	-	-	-

Figure A-8. Single-Wiring-Closet Lobe Lengths in Meters (Type 9 Cable) for 16 Mbps Rings

Multiple-Wiring-Closet Rings

		NUMBER OF WIRING CLOSETS										
		2	3	4	5	6	7	8	9	10	11	12
NUMBER OF 8228s	2	1192										
	3	1163	1148									
	4	1135	1120	1104								
	5	1106	1091	1076	1061							
	6	1078	1062	1047	1032	1017						
	7	1049	1034	1019	1004	989	974					
	8	1020	1005	990	975	960	945	930				
	9	992	977	962	947	932	916	901	886			
	10	963	948	933	918	903	888	873	858	843		
	11	935	920	905	890	874	859	844	829	814	799	
	12	906	891	876	861	846	831	816	801	786	770	755
	13	878	863	848	833	817	802	787	772	757	742	727
	14	849	834	819	804	789	774	759	744	729	713	698
	15	821	806	791	775	760	745	730	715	700	685	670
	16	792	777	762	747	732	717	702	687	671	656	641
	17	764	749	733	718	703	688	673	658	643	628	613
	18	735	720	705	690	675	660	645	629	614	599	584
	19	707	691	676	661	646	631	616	601	586	571	556
	20	678	663	648	633	618	603	587	572	557	542	527
	21	649	634	619	604	589	574	559	544	529	514	499
	22	621	606	591	576	561	545	530	515	500	485	470
	23	592	577	562	547	532	517	502	487	472	457	441
	24	564	549	534	519	503	488	473	458	443	428	413
	25	502	520	505	490	475	460	445	430	415	399	384
	26	474	492	477	461	446	431	416	401	386	371	356
	27	445	463	448	433	418	403	388	373	357	342	327

Figure A-9. 4 Mbps Allowable Drive Distances in Feet (Type 1 or 2 Cable) without Using Repeaters or Converters

NUMBER OF WIRING CLOSETS

	2	3	4	5	6	7	8	9	10	11	12
2	363										
3	354	350									
4	346	341	336								
5	337	332	328	323							
6	328	324	319	314	310						
7	319	315	310	306	301	296					
8	311	306	302	297	292	288	283				
9	302	297	293	288	284	279	274	270			
10	293	289	284	280	275	270	266	261	257		
11	285	280	275	271	266	262	257	252	248	243	
12	276	271	267	262	258	253	248	244	239	235	230
13	267	263	258	253	249	244	240	235	230	226	221
14	259	254	249	245	240	236	231	226	222	217	213
15	250	245	241	236	231	227	222	218	213	208	204
16	241	237	232	227	223	218	214	209	204	200	195
17	232	228	223	219	214	209	205	200	196	191	186
18	224	219	215	210	205	201	196	192	187	182	178
19	215	210	206	201	197	192	187	183	178	174	169
20	206	202	197	193	188	183	179	174	170	165	160
21	198	193	188	184	179	175	170	165	161	156	152
22	189	184	180	175	171	166	161	157	152	148	143
23	180	176	171	166	162	157	153	148	143	139	134
24	172	167	162	158	153	149	144	139	135	130	126
25	153	158	154	149	144	140	135	131	126	121	117
26	144	150	145	140	136	131	127	122	117	113	108
27	135	141	136	132	127	122	118	113	109	104	99

Figure A-10. 4 Mbps Allowable Drive Distances in Meters (Type 1 or 2 Cable) without Using Repeaters or Converters

NUMBER OF WIRING CLOSETS

	0	1	2	3	4	5	6	7	8	9	10	11	12
1		1235											
2		1207	1192										
3		1178	1163	1148									
4		1150	1135	1120	1104								
5		1121	1106	1091	1076	1061							
6		1093	1078	1062	1047	1032	1017						
7		1064	1049	1034	1019	1004	989	974					
8		1036	1020	1005	990	975	960	945	930				
9		1007	992	977	962	947	932	916	901	886			
10		979	963	948	933	918	903	888	873	858	843		
11		950	935	920	905	890	874	859	844	829	814	799	
12		921	906	891	876	861	846	831	816	801	786	770	755
13		860	878	863	848	833	817	802	787	772	757	742	727
14		832	849	834	819	804	789	774	759	744	729	713	698
15		803	821	806	791	775	760	745	730	715	700	685	670
16		774	792	777	762	747	732	717	702	687	671	656	641
17		746	764	749	733	718	703	688	673	658	643	628	613
18		717	735	720	705	690	675	660	645	629	614	599	584
19		689	707	691	676	661	646	631	616	601	586	571	556
20		660	678	663	648	633	618	603	587	572	557	542	527
21		632	649	634	619	604	589	574	559	544	529	514	499
22		603	621	606	591	576	561	545	530	515	500	485	470
23		575	592	577	562	547	532	517	502	487	472	457	441
24		546	564	549	534	519	503	488	473	458	443	428	413
25		485	502	520	505	490	475	460	445	430	415	399	384
26		456	474	492	477	461	446	431	416	401	386	371	356
27		428	445	463	448	433	418	403	388	373	357	342	327

Figure A-11. 4 Mbps Allowable Drive Distances in Feet (Type 1 or 2 Cable) with Repeaters or Converters

NUMBER OF WIRING CLOSETS

	1	2	3	4	5	6	7	8	9	10	11	12
1	376											
2	368	363										
3	359	354	350									
4	350	346	341	336								
5	341	337	332	328	323							
6	333	328	324	319	314	310						
7	324	319	315	310	306	301	296					
8	315	311	306	302	297	292	288	283				
9	307	302	297	293	288	284	279	274	270			
10	298	293	289	284	280	275	270	266	261	257		
11	289	285	280	275	271	266	262	257	252	248	243	
12	281	276	271	267	262	258	253	248	244	239	235	230
13	262	267	263	258	253	249	244	240	235	230	226	221
14	253	259	254	249	245	240	236	231	226	222	217	213
15	244	250	245	241	236	231	227	222	218	213	208	204
16	236	241	237	232	227	223	218	214	209	204	200	195
17	227	232	228	223	219	214	209	205	200	196	191	186
18	218	224	219	215	120	205	201	196	192	187	182	178
19	210	215	210	206	201	197	192	187	183	178	174	169
20	201	206	202	197	193	188	183	179	174	170	165	160
21	192	198	193	188	184	179	175	170	165	161	156	152
22	184	189	184	180	175	171	166	161	157	152	148	143
23	175	180	176	171	166	162	157	153	148	143	139	134
24	166	172	167	162	158	153	149	144	139	135	130	126
25	147	153	158	154	149	144	140	135	131	126	121	117
26	139	144	150	145	140	136	131	127	122	117	113	108
27	130	135	141	136	132	127	122	118	113	109	104	99

Figure A-12. 4 Mbps Allowable Drive Distances in Meters (Type 1 or 2 Cable) with Repeaters or Converters

NUMBER OF WIRING CLOSETS

	2	3	4	5	6	7	8	9	10	11	12
2	794										
3	775	765									
4	756	746	736								
5	737	727	717	707							
6	718	708	698	688	678						
7	699	689	679	669	659	649					
8	680	670	660	650	640	630	620				
9	661	651	641	631	621	611	601	591			
10	642	632	622	612	602	592	582	572	562		
11	623	613	603	593	583	573	563	553	543	533	
12	604	594	584	574	564	554	544	534	524	514	503
13	585	575	565	555	545	535	525	515	505	494	484
14	566	556	546	536	526	516	506	496	486	475	465
15	547	537	527	517	507	497	487	477	466	456	446
16	528	518	508	498	488	478	468	458	447	437	427
17	509	499	489	479	469	459	449	438	428	418	408
18	490	480	470	460	450	440	430	419	409	399	389
19	471	461	451	441	431	421	410	400	390	380	370
20	452	442	432	422	412	402	391	381	371	361	351
21	433	423	413	403	393	383	372	362	352	342	332
22	414	404	394	384	374	363	353	343	333	323	313
23	395	385	375	365	355	344	334	324	314	304	294
24	376	366	356	346	335	325	315	305	295	285	275
25	357	347	337	327	316	306	296	286	276	266	256
26	338	328	318	307	297	287	277	267	257	247	237
27	319	309	299	288	278	268	258	248	238	228	218

Figure A-13. 4 Mbps Allowable Drive Distances in Feet (Type 9 Cable Only) without Repeaters or Converters

NUMBER OF WIRING CLOSETS

	2	3	4	5	6	7	8	9	10	11	12
2	242										
3	236	233									
4	230	227	224								
5	224	221	218	215							
6	219	216	212	209	206						
7	213	210	207	204	201	197					
8	207	204	201	198	195	192	189				
9	201	198	195	192	189	186	183	180			
10	195	192	189	186	183	180	177	174	171		
11	190	187	183	180	177	174	171	168	165	162	
12	184	181	178	175	172	168	165	162	159	156	153
13	178	175	172	169	166	163	160	157	153	150	147
14	172	169	166	163	160	157	154	151	148	145	142
15	166	163	160	157	154	151	148	145	142	139	136
16	161	158	154	151	148	145	142	139	136	133	130
17	155	152	149	146	143	139	136	133	130	127	124
18	149	146	143	140	137	134	131	128	124	121	118
19	143	140	137	134	131	128	125	122	119	116	113
20	137	134	131	128	125	122	119	116	113	110	107
21	132	129	125	122	119	116	113	110	107	104	101
22	126	123	120	117	114	110	107	104	101	98	95
23	120	117	114	111	108	105	102	99	95	92	89
24	114	111	108	105	102	99	96	93	90	87	84
25	102	105	102	99	96	93	90	87	84	81	78
26	96	100	96	93	90	87	84	81	78	75	72
27	90	94	91	88	85	81	78	75	72	69	66

Figure A-14. 4 Mbps Allowable Drive Distances in Meters (Type 9 Cable Only) without Repeaters or Converters

NUMBER OF WIRING CLOSETS

	1	2	3	4	5	6	7	8	9	10	11	12
1	823											
2	804	794										
3	785	775	765									
4	766	756	746	736								
5	747	737	727	717	707							
6	728	718	708	698	688	678						
7	709	699	689	679	669	659	649					
8	690	680	670	660	650	640	630	620				
9	671	661	651	641	631	621	611	601	591			
10	652	642	632	622	612	602	592	582	572	562		
11	633	623	613	603	593	583	573	563	553	543	533	
12	614	604	594	584	574	564	554	544	534	524	514	503
13	573	585	575	565	555	545	535	525	515	505	494	484
14	554	566	556	546	536	526	516	506	496	486	475	465
15	535	547	537	527	517	507	497	487	477	466	456	446
16	516	528	518	508	498	488	478	468	458	447	437	427
17	497	509	499	489	479	469	459	449	438	428	418	408
18	478	490	480	470	460	450	440	430	419	409	399	389
19	459	471	461	451	441	431	421	410	400	390	380	370
20	440	452	442	432	422	412	402	391	381	371	361	351
21	421	433	423	413	403	393	383	372	362	352	342	332
22	402	414	404	394	384	374	363	353	343	333	323	313
23	383	395	385	375	365	355	344	334	324	314	304	294
24	364	376	366	356	346	335	325	315	305	295	285	275
25	323	335	347	337	327	316	306	296	286	276	266	256
26	304	316	328	318	307	297	287	277	267	257	247	237
27	285	297	309	299	288	278	268	258	248	238	228	218

Figure A-15. 4 Mbps Allowable Drive Distances in Feet (Type 9 Cable Only) with Repeaters or Converters

NUMBER OF WIRING CLOSETS

	1	2	3	4	5	6	7	8	9	10	11	12
1	251											
2	245	242										
3	239	236	233									
4	233	230	227	224								
5	227	224	221	218	215							
6	222	219	216	212	209	206						
7	216	213	210	207	204	201	197					
8	210	207	204	201	198	195	192	189				
9	204	201	198	195	192	189	186	183	180			
10	198	195	192	189	186	183	180	177	174	171		
11	193	190	187	183	180	177	174	171	168	165	162	
12	187	184	181	178	175	172	168	165	162	159	156	153
13	174	178	175	172	169	166	163	160	157	153	150	147
14	169	172	169	166	163	160	157	154	151	148	145	142
15	163	166	163	160	157	154	151	148	145	142	139	136
16	157	161	158	154	151	148	145	142	139	136	133	130
17	151	155	152	149	146	143	139	136	133	130	127	124
18	145	149	146	143	140	137	134	131	128	124	121	118
19	140	143	140	137	134	131	128	125	122	119	116	113
20	134	137	134	131	128	125	122	119	116	113	110	107
21	128	132	129	125	122	119	116	113	110	107	104	101
22	122	126	123	120	117	114	110	107	104	101	98	95
23	116	120	117	114	111	108	105	102	99	95	92	89
24	111	114	111	108	105	102	99	96	93	90	87	84
25	98	102	105	102	99	96	93	90	87	84	81	78
26	92	96	100	96	93	90	87	84	81	78	75	72
27	87	90	94	91	88	85	81	78	75	72	69	66

Figure A-16. 4 Mbps Allowable Drive Distances in Meters (Type 9 Cable Only) with Repeaters or Converters

NUMBER OF WIRING CLOSETS

	2	3	4	5	6	7	8	9	10
2	530								
3	509	492							
4	487	471	454						
5	465	449	432	416					
6	443	427	411	394	378				
7	422	405	389	372	356	340			
8	400	383	367	350	344	318	301		
9	378	361	345	329	312	296	279	263	
10	356	340	323	307	290	274	258	241	225
11	334	318	301	285	269	252	236	219	203
12	312	296	279	263	247	230	214	197	181
13	270	253	236	220	204	188	171	155	138
14	227	211	194	178	161	145	129	112	96
15	184	168	152	135	119	102	86	69	53
16	142	125	109	92	76	60	43	27	10
17	99	83	66	50	33	17	-	-	-
18	56	40	24	-	-	-	-	-	-

Figure A-17. 16 Mbps Allowable Drive Distances in Feet (Type 1 or 2 Cable) without Converters

		NUMBER OF WIRING CLOSETS								
		2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	2	162								
	3	155	150							
	4	149	144	139						
	5	142	137	132	127					
	6	135	130	125	120	115				
	7	129	124	119	114	109	104			
	8	122	117	112	107	102	97	92		
	9	115	110	105	100	95	90	85	80	
	10	109	104	99	94	89	84	79	74	69
	11	102	97	92	87	82	77	72	67	62
	12	95	90	85	80	75	70	65	60	55
	13	82	77	72	67	62	57	52	47	42
	14	69	64	59	54	49	44	39	34	29
	15	56	51	46	41	36	31	26	21	16
	16	43	38	33	28	23	18	13	8	3
	17	30	25	20	15	10	5	-	-	-
	18	17	12	7	-	-	-	-	-	-

Figure A-18. 16 Mbps Allowable Drive Distances in Meters (Type 1 or 2 Cable) without Converters

		NUMBER OF WIRING CLOSETS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	569									
	2	547	530								
	3	525	509	492							
	4	503	487	471	454						
	5	482	465	449	432	416					
	6	460	443	427	411	394	378				
	7	438	422	405	389	372	356	340			
	8	416	400	383	367	350	344	318	301		
	9	394	378	361	345	329	312	296	279	263	
	10	372	356	340	323	307	290	274	258	241	225
	11	351	334	318	301	285	269	252	236	219	203
	12	329	312	296	279	263	247	230	214	197	181
	13	253	270	253	236	220	204	188	171	155	138
	14	211	227	211	194	178	161	145	129	112	96
	15	168	184	168	152	135	119	102	86	69	53
	16	125	142	125	109	92	76	60	43	27	10
	17	83	99	83	66	50	33	17	-	-	-
	18	40	56	40	24	-	-	-	-	-	-

Figure A-19. 16 Mbps Allowable Drive Distances in Feet (Type 1 or 2 Cable) with Converters

		NUMBER OF WIRING CLOSETS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 82288	1	173									
	2	167	162								
	3	160	155	150							
	4	154	149	144	139						
	5	147	142	137	132	127					
	6	140	135	130	125	120	115				
	7	134	129	124	119	114	109	104			
	8	127	122	117	112	107	102	97	92		
	9	120	115	110	105	100	95	90	85	80	
	10	114	109	104	99	94	89	84	79	74	69
	11	107	102	97	92	87	82	77	72	67	62
	12	100	95	90	85	80	75	70	65	60	55
	13	77	82	77	72	67	62	57	52	47	42
	14	64	69	64	59	54	49	44	39	34	29
	15	51	56	51	46	41	36	31	26	21	16
	16	38	43	38	33	28	23	18	13	8	3
	17	25	30	25	20	15	10	5	-	-	-
	18	12	17	12	7	-	-	-	-	-	-

Figure A-20. 16 Mbps Allowable Drive Distances in Meters (Type 1 or 2 Cable) with Converters

		NUMBER OF WIRING CLOSETS								
		2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	2	354								
	3	339	328							
	4	325	314	303						
	5	310	299	288	277					
	6	296	285	274	263	252				
	7	281	270	259	248	237	226			
	8	266	255	244	233	222	211	200		
	9	252	241	230	219	208	197	186	175	
	10	237	226	215	204	193	182	171	160	149
	11	223	212	201	190	179	168	157	146	135
	12	208	197	186	175	164	153	142	131	120
	13	180	169	158	147	136	125	114	103	92
	14	151	140	129	118	107	96	85	74	63
	15	123	112	101	90	79	68	57	46	35
	16	94	84	73	62	51	40	29	18	7
	17	66	55	44	33	22	11	-	-	-
	18	38	27	16	-	-	-	-	-	-

Figure A-21. 16 Mbps Allowable Drive Distances in Feet (Type 9 Cable Only) without Converters

		NUMBER OF WIRING CLOSETS								
		2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	2	108								
	3	103	100							
	4	99	96	92						
	5	95	91	88	85					
	6	90	87	83	80	77				
	7	86	82	79	76	72	69			
	8	81	78	75	71	69	65	61		
	9	77	73	70	67	63	60	57	53	
	10	72	69	66	62	59	56	52	49	46
	11	68	66	61	58	55	52	48	45	41
	12	63	60	57	53	50	47	43	40	37
	13	55	51	48	45	42	38	35	31	28
	14	46	42	39	36	33	29	26	23	19
	15	37	34	31	27	24	21	17	14	11
	16	28	25	22	19	15	12	9	5	2
	17	20	17	14	10	7	3	-	-	-
	18	11	8	5	-	-	-	-	-	-

Figure A-22. 16 Mbps Allowable Drive Distances in Meters (Type 9 Cable Only) without Converters

		NUMBER OF WIRING CLOSETS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	379									
	2	365	354								
	3	350	339	328							
	4	336	325	314	303						
	5	321	310	299	288	277					
	6	306	296	285	274	263	252				
	7	292	281	270	259	248	237	226			
	8	277	266	255	244	233	222	211	200		
	9	263	252	241	230	219	208	197	186	175	
	10	248	237	226	215	204	193	182	171	160	149
	11	234	223	212	201	190	179	168	157	146	135
	12	219	208	197	186	175	164	153	142	131	120
	13	169	180	169	158	147	136	125	114	103	92
	14	140	151	140	129	118	107	96	85	74	63
	15	112	122	112	101	90	79	68	57	46	35
	16	84	94	84	73	62	51	40	29	18	7
	17	55	66	55	44	33	22	11	-	-	-
	18	27	38	27	16	-	-	-	-	-	-

Figure A-23. 16 Mbps Allowable Drive Distances in Feet (Type 9 Cable Only) with Converters

		NUMBER OF WIRING CLOSETS									
		1	2	3	4	5	6	7	8	9	10
NUMBER OF 8228s	1	116									
	2	111	108								
	3	107	103	100							
	4	102	99	96	92						
	5	98	95	91	88	85					
	6	93	90	87	83	80	77				
	7	89	86	82	79	76	72	69			
	8	84	81	78	75	71	69	65	61		
	9	80	77	73	70	67	63	60	57	53	
	10	76	72	69	66	62	59	56	52	49	46
	11	71	68	66	61	58	55	52	48	45	41
	12	67	63	60	57	53	50	47	43	40	37
	13	51	55	51	48	45	42	38	35	31	28
	14	42	46	42	39	36	33	29	26	23	19
	15	34	37	34	31	27	24	21	17	14	11
	16	25	28	25	22	19	15	12	9	5	2
	17	17	20	17	14	10	7	3	-	-	-
	18	8	11	8	5	-	-	-	-	-	-

Figure A-24. 16 Mbps Allowable Drive Distances in Meters (Type 9 Cable Only) with Converters

Additional Rules for Planning Rings with Repeaters, Converters, and Controlled Access Units

Once you have determined that your ring needs either repeaters or converters to provide adequate geographic coverage, you must plan for placing the repeaters or converters in the main ring path. **Repeaters and converters will not function on lobes.**

Since repeaters and converters both regenerate the signals they receive, placing them on the main ring path allows the segment of the ring between repeaters or converters to be treated as a complete ring for the purpose of drive distances. However, the total number of attaching devices on a single ring is still 260. Further, the number of attaching devices permitted on the ring is decreased by one for each 8218 or 8219 repeater placed in the main ring path. Each 8220 converter reduces the number of attaching devices permitted on the ring by two. Each 8230 in the ring reduces the total number of attaching devices permitted by three.

Whether you choose repeaters or converters for your ring depends upon the ring data rate, the availability of optical fiber cabling for the main ring path, and the possibility of migrating from a 4 to a 16 Mbps ring at some later date.

- Rings planned for operation at 4 Mbps may use 8218s, 8219s, 8220s, or 8230s.
- Rings planned for operation at 16 Mbps may use 8220s and 8230s using optical fiber cabling in the main ring path. IBM 8230s also provide repeating capability on copper cabling.
- If you are planning a ring for immediate operation at 4 Mbps but anticipate that the ring will be upgraded to 16 Mbps operation at a later date, you should use only 8220s or 8230s.

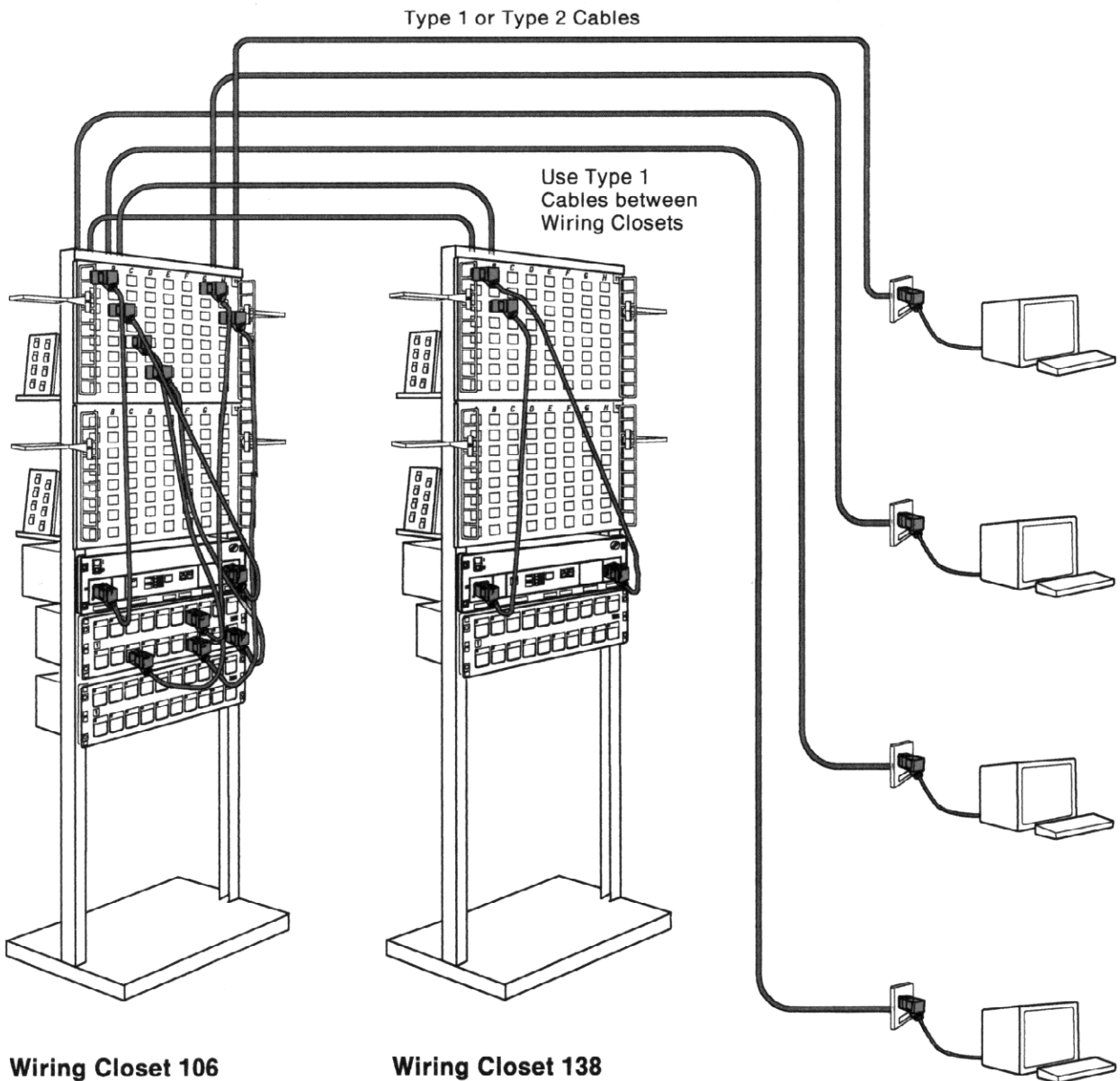
If your ring will have 8228s installed in two or more wiring closets, you will use the charts in the beginning of this appendix for multiple-wiring-closet rings to determine the allowable drive distance for your ring. A work area with one or more 8228s installed should be treated as though it were a separate wiring closet. IBM 8228s installed in a work area should be connected to each other and to the faceplates in the work area with 8-foot patch cables. All 8228s not installed in racks should be installed in component housings.

If your ring will have surge suppressors attached to cables between wiring closets and will operate at 4 Mbps, use the information later in this appendix to determine the allowable size of your network. Surge suppressors are not permitted in 16 Mbps rings. Optical fiber cable must be used for cabling between buildings in such instances.

The numbers in the charts that appear earlier in this appendix are based upon the following cabling assumptions. If you cannot stay within these assumptions, the information in the last section of this appendix will help you calculate adjustments to cable length so that you may use the chart accurately. Figure 2-6 on page 2-18 illustrates the multiple-wiring-closet cabling assumptions.

- Use one 2.4-m (8-ft) cable between the attaching device and the faceplate in the work area (if the attaching device is an IBM Personal Computer, this will be the IBM Token-Ring Network PC Adapter Cable).¹
- Use 2.4-m (8-ft) patch cables between the distribution panel and the 8228 or 8230.¹
- Use 2.4-m (8-ft) patch cables between 8228s or 8230s in the same rack.¹
- Use 9-m (30-ft) patch cables between 8228s or 8230s in different racks.¹
- All drops must be IBM Cabling System type 1 or 2 cable. See the last section of this appendix if you are substituting other types of IBM Cabling System Cable for type 1 or 2.
- The multiple-wiring-closet charts assume that up to 12 IBM 8228s are installed in each rack. If a ring can be configured with no more than 12 IBM 8228s per wiring closet, then the chart assumes that a single rack is used. If not, the minimum number of additional racks and 30-foot patch cables is assumed.
- All wiring closet-to-wiring closet connections must use IBM Cabling System type 1, 2, or 9 cable for copper ring path segments. Use 62.5/125-micron optical fiber cable for ring segments between 8219s, 8220s, and 8230s with the optical fiber module installed.
 - For information on using telephone twisted-pair media at a data rate of 4 Mbps, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*. Operation at 16 Mbps on telephone twisted-pair media is not supported.

¹ Shorter lengths may be used.



Wiring Closet 106

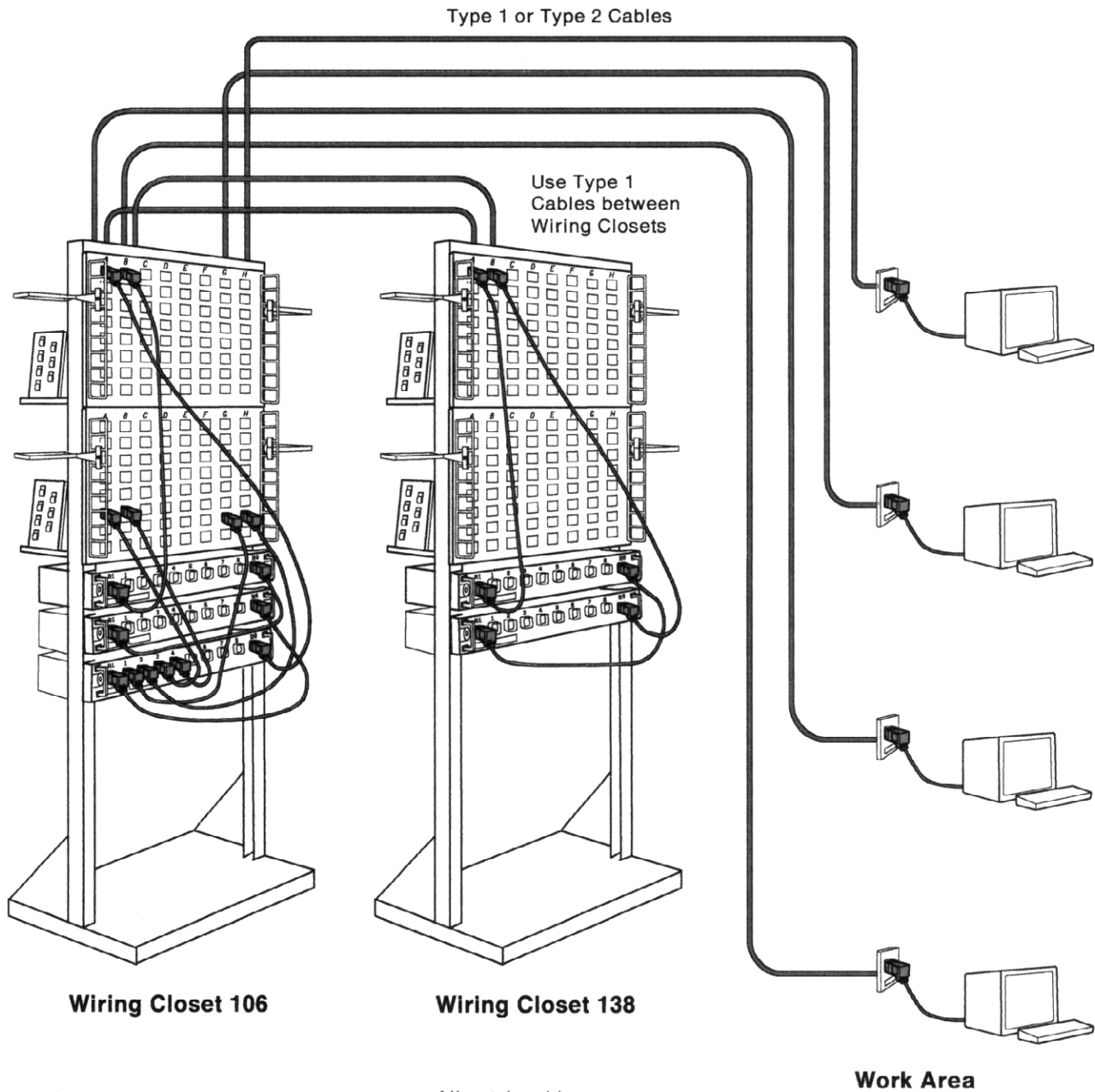
This figure shows only how the cables are connected, not how they should be routed.

Wiring Closet 138

All patch cables within racks are 8 Ft

Work Area

Figure A-25. Multiple-Wiring-Closet Installation Assumptions for Rings Using 8230s



This figure shows only how the cables are connected, not how they should be routed.

All patch cables within racks are 8 Ft.

Figure A-26. Multiple-Wiring-Closet Installation Assumptions for Rings Using 8228s

- To convert type 9 cable lengths to their type 1 equivalents, multiply the length of type 9 cable by 3/2.
- For conversion factors for IBM Cabling System types 6 and 8, see the last section of this appendix.

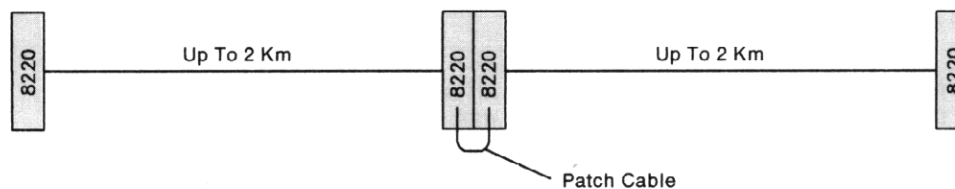
4 and 16 Mbps Rings Using 8219s, 8220s, and 8230s with Optical Fiber Cable

If you have optical fiber cable in the main ring path, each run of optical fiber cable must be connected to the copper portion of the main ring path using 8219 Optical Fiber Repeaters (4 Mbps only), 8220 Optical Fiber Converters (either 4 or 16 Mbps), or 8230s with optical fiber modules (either 4 or 16 Mbps). 8230 base units can be installed either with or without Lobe Attachment Modules (LAMs).

Optical fiber cabling is frequently useful to carry the signal over those segments of the main ring path that are especially long, over segments between buildings to eliminate ground potential difference and lightning surge problems, or over segments subject to excessively high levels of electromagnetic interference. A 16 Mbps ring that covers two or more buildings requires optical fiber cabling for all interbuilding cables, since there is not a 16 Mbps surge suppressor available. In addition to its other benefits, optical fiber cable provides better security for your network in that it is not easily tapped.

Using the sketch of your proposed ring that you prepared earlier, identify where optical fiber is already installed where it is an attractive alternative. For each run of optical fiber cable, you will need an 8219, 8220, or 8230 at each end. You cannot use 8219s, 8220s, and 8230s in the same optical fiber subsystem. (An optical fiber subsystem is a segment of the main ring path containing only optical fiber cabling with a converter or repeater at each end.) However, 8219s, 8220s, and 8230s may be used in different optical fiber subsystems in the main ring path of a 4 Mbps ring. Similarly, 8220s and 8230s may be used in different optical fiber subsystems in the main ring path of a 16 Mbps ring.

If you are using 62.5/125-micron optical fiber cable that meets the specifications found in Appendix D for cable runs of from 2.4m (8 ft) to 1.5 km (4920 ft) you may have as many as four pairs of optical fiber connectors between 8219s, 8220s, and 8230s. If only two pairs of optical fiber connectors are present (a pair at each distribution panel in a two-wiring-closet subsystem, for example), then up to 2 km (6560 ft) are permitted. Any cable run longer than 2 km (6560 ft) must have 8219s, 8220s, or 8230s (acting as repeaters) at least every 2 km (6560 ft) in the cable run. (See *IBM Token-Ring Network Optical Fiber Cable Options* for instructions on qualifying lengths of optical fiber cable that do not fall within these guidelines for use in a network.)



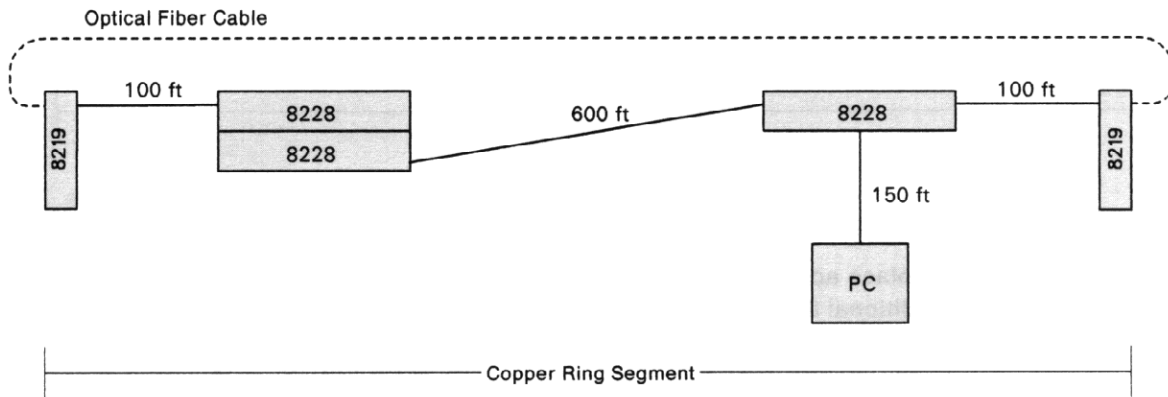
After you have decided where in your ring you want to use optical fiber cabling, you must evaluate the remaining copper portion of the ring containing 8228s and copper cabling to determine if additional converters or repeaters are necessary. Follow the instructions in the remaining portion of this chapter to make this determination.

4 Mbps Rings Using 8219 Optical Fiber Repeaters

Previously you have defined on your sketch of the proposed ring where you will locate 8219s. Now you must determine if the main ring segment or segments containing all copper cabling are within the drive distance allowances found in the table in Figure 2-13 on page 2-29. Each of these main ring segments are bounded by 8219s or a combination of 8218s on one side and an 8219 on the other. You must determine the drive distance for each copper ring segment according to one of the three following situations.

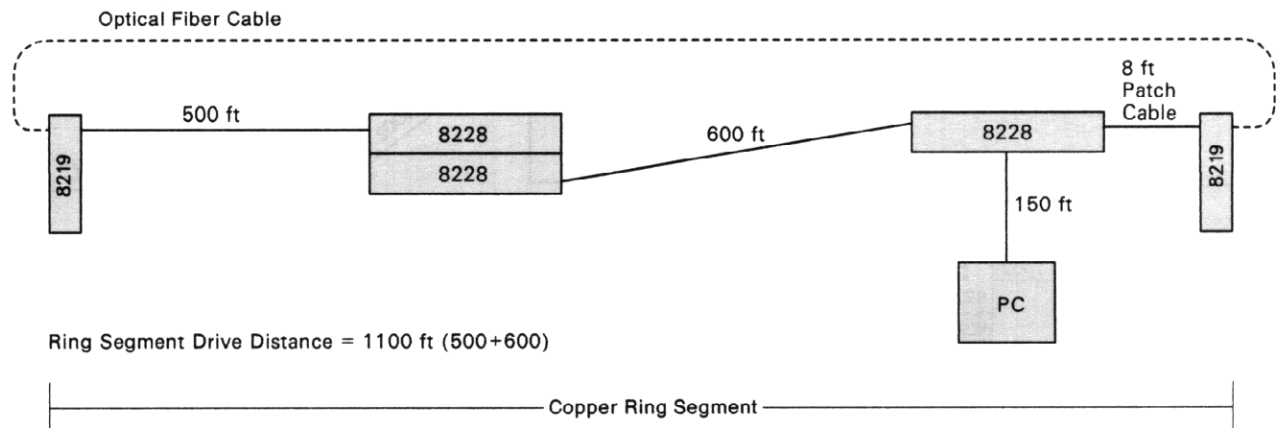
- Situation 1: The length of the longest lobe is greater than the length of either of the cables between the pairs of repeaters and the nearest 8228.

The ring segment drive distance is the sum of the longest lobe length plus the length of all of the cables (excluding patch cables) between the first and last 8228s in the ring segment.



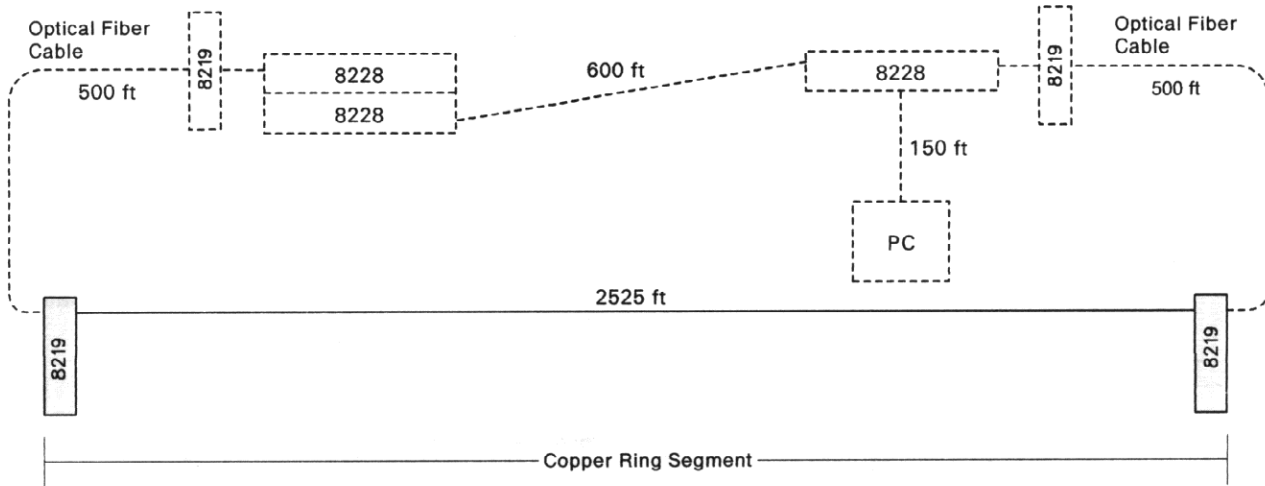
- Situation 2: The length of the longest lobe is less than the length of one or both of the cables between repeaters and their closest 8228s.

The ring segment drive distance is the sum of the longer of the two lengths of cable between repeaters and their nearest 8228s and the total of all of the cables bounded by the first and last 8228 in the segment.



- Situation 3: There are no 8228s in the copper ring segment.

The allowable drive distance is 770 m (2525 ft) on type 1 copper cable between pairs of repeaters.



If the ring segment exceeds the allowable drive distance in the chart in Figure 2-13 on page 2-29, you must do one of the following:

- Replace additional segments of copper cabling with optical fiber cable and use additional 8219s, 8220s, or 8230s.
- Place 8218s in the ring segment as described in "4 Mbps Rings Using 8218s" on page A-33. When applying the rules in that section, treat the 8219 at the beginning of the copper ring segment as a pair of 8218s.

Figure A-27 shows a ring with intermixed cable in its main ring path. The sum of the lengths of the type 1 cable is indicated, and the longest lobe on the ring that is applicable to the drive distance calculation is identified.

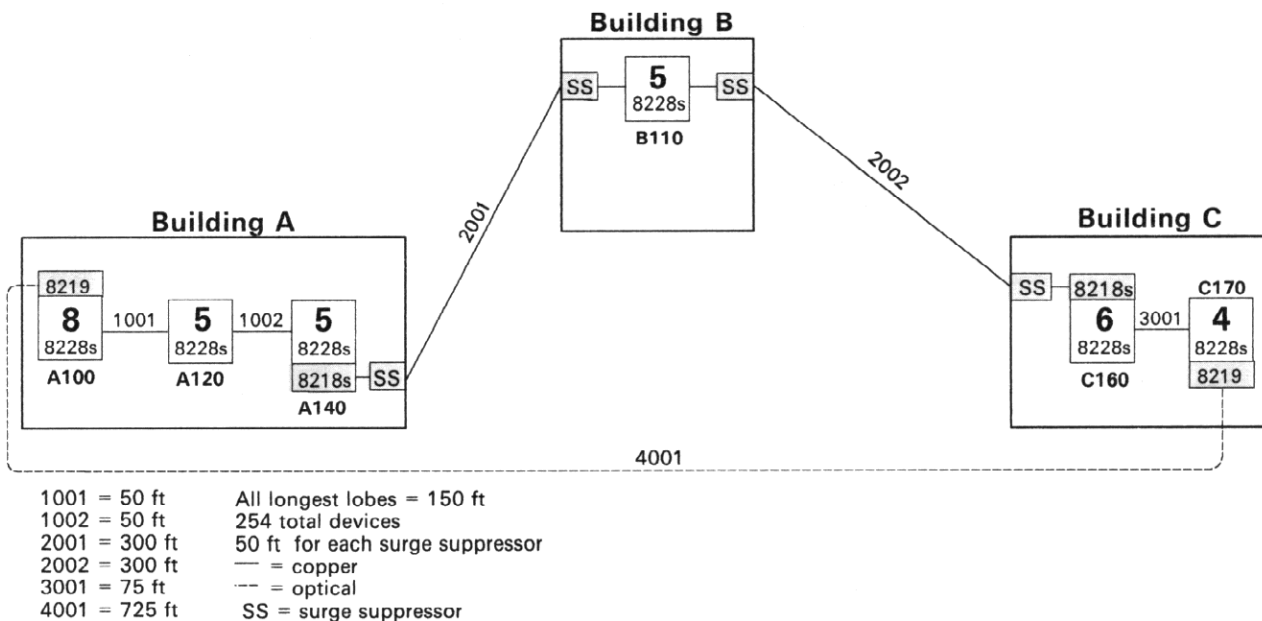


Figure A-27. A 4 Mbps Ring with Intermixed Main Ring Path Cabling Using 8219s

Using Copper Repeaters

You should use this section to plan 4 Mbps rings that have no optical fiber cabling and are too large to operate without 8218s or 8230s with copper modules installed. In addition, this section will allow you to evaluate the all-copper ring segments of 4 and 16 Mbps rings that use 8219s (4 Mbps only), 8220s, or 8230s with optical fiber modules installed (either 4 or 16 Mbps). Finally, this section will explain how to use 8230s base units, with or without LAMs, installed as copper repeaters in rings that also contain 8228s and 8220s. A ring segment is a portion of the main ring path bounded on both ends by repeaters or converters.

4 Mbps Rings Using 8218s

The 8218 allows you to construct 4 Mbps rings over a greater geographic area than indicated in the chart in Figure 2-9 on page 2-23. To plan for repeaters, you will need the rough sketch of your ring.

Repeaters allow you to consider the ring segment between any two pairs of repeaters as a ring for purposes of determining the allowable drive distance (the length of cable and devices over which a signal can be reliably transmitted). IBM 8218s are always placed on the main ring path in pairs to provide a reliable backup path for the network. Repeaters are never used on lobes. As you are planning your ring, remember that the number of attaching devices supported on a single ring using 8218s and 8219s is equal to 260 minus the total number of 8218s and 8219s on the ring. Each 8220 on the ring reduces the total number of attaching devices supported on a ring by two. Each 8230 reduces the total number of attaching devices supported on a ring by three. Remember that all of the cabling assumptions for multiple-wiring-closet networks listed earlier in this chapter should still be followed.

To plan for the placement of copper repeaters on your ring, perform the following steps:

1. Place the first pair of 8218s at the input (before the first 8228) to the wiring closet with the greatest number of 8228s. Since configurations can differ greatly, this first placement of repeaters is not an absolute requirement, but rather a suggestion that works best in typical cases.
2. Place the next pair of repeaters as far from the previous pair as possible without exceeding the allowable drive distance limitations in the chart in Figure 2-13 on page 2-29.

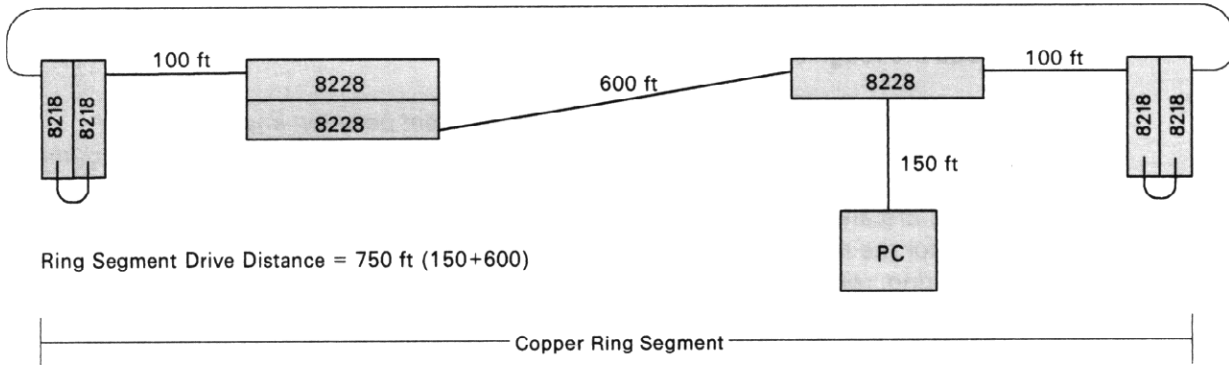
Note: For expansion purposes, you may want to place this pair of repeaters closer to the previous pair than the maximum allowable drive distance allowed in the chart. Frequently, for purposes both of planning and expansion, the most convenient location for a pair of repeaters is at the input or output of a wiring closet.

3. Calculate the drive distance of a segment:
 - a. Treat each ring segment between repeaters separately, calculating a drive distance for each segment of the ring.
 - b. For any ring segment that contains surge suppressors, add 30 m (100 ft) per surge suppressor to the length of the cable section containing the surge suppressor.
 - c. Determine the length of the longest lobe attached to the ring segment either by measurement on a copy of your floor plan or from the Cable Schedules.

d. Determine the length of the cable between each pair of repeaters and the closest 8228 to them in the ring segment. (If the only cable between a repeater and an 8228 is a 2.4-m (8-ft) patch cable, assume that the distance is zero.) Determine this distance for both pairs of repeaters in the segment.

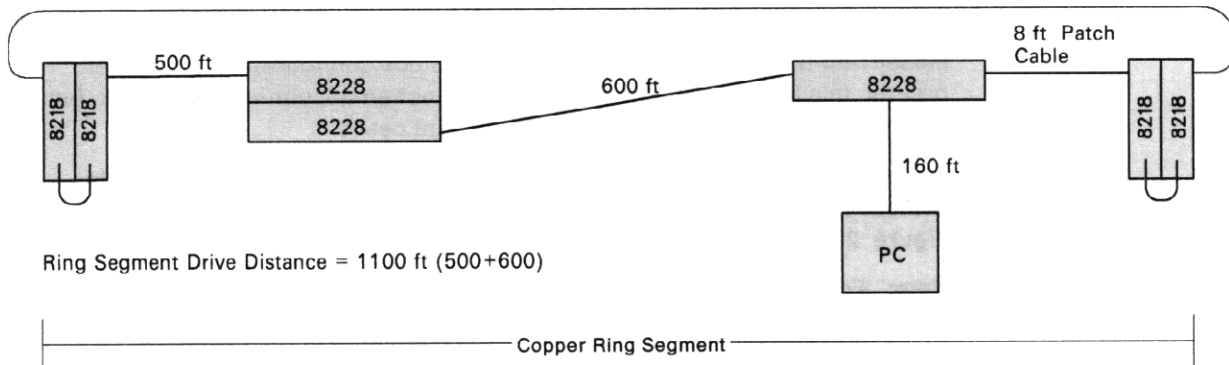
- Situation 1: The length of the longest lobe is greater than the length of either of the cables between the pairs of repeaters and the nearest 8228.

The ring segment drive distance is the sum of the longest lobe length plus the length of all of the cables (excluding patch cables) between the first and last 8228 in the ring segment.



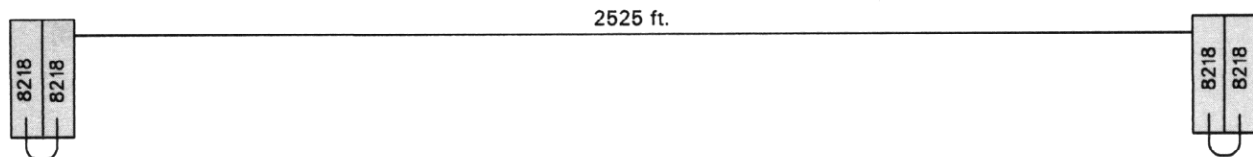
- Situation 2: The length of the longest lobe is less than the length of one or both of the cables between repeaters and their closest 8228s.

The ring segment drive distance is the sum of the longer of the two lengths of cable between repeaters and their nearest 8228s and the total of all of the cables bounded by the first and last 8228 in the segment.



- Situation 3: There are no 8228s in the copper ring segment.

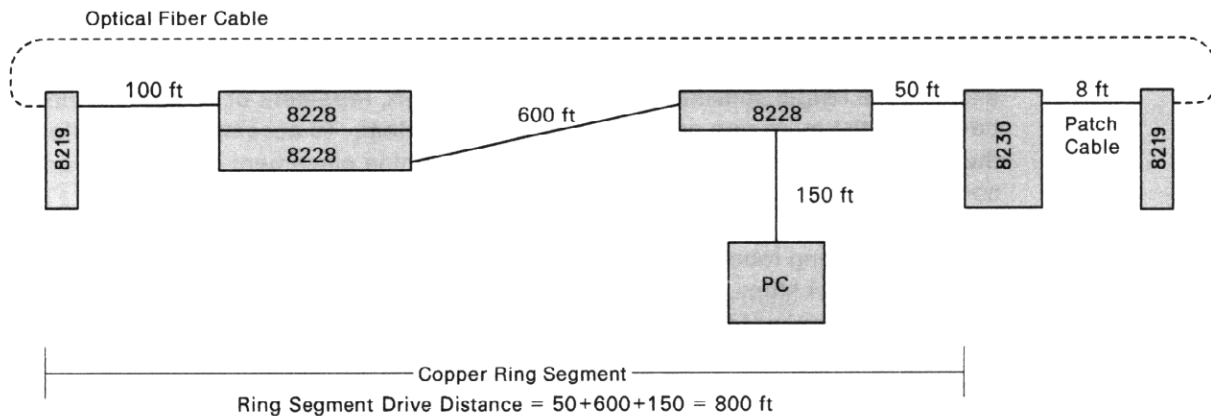
The allowable drive distance is 770 m (2525 ft) over type 1 copper cable between pairs of repeaters. If there are surge suppressors between the 8218s, reduce the allowable drive distance by 30 m (100 ft) for each surge suppressor.



4. Now that you have determined a location for the second pair of repeaters on your ring and calculated the drive distance for one of the segments, you need to check the remaining ring segment as described in step 3 above.
 - If the drive distance is within the limits in the allowable drive distance chart in Figure 2-13 on page 2-29, go on to the section in this chapter called "Filling Out the Planning Documents."
 - If the drive distance is not within the chart limits, continue placing pairs of repeaters until the final ring segment is within an allowable drive distance.

Using 8230s with 8218s and 8219s

For all copper ring segments containing 8228s and bounded on one side by 8220s or 8230s and on the other by 8218s or 8219s, the ring segment drive distance is the sum of the length of cable between the 8220 or 8230 and the 8228 nearest to it plus the length of cable between 8228s, and either the length of the longest lobe in the segment or the distance between the 8218 or 8219 and its nearest 8228, whichever is greater.



Single-Wiring-Closet Rings Using 8228s with Lobes Longer than 100 Meters

In most cases you should limit the length of the longest lobe on a ring to 100 m (330 ft), because longer lobes may limit expansion possibilities in the future. Nevertheless, in some rings a single long lobe may be necessary to serve an attaching device that is a great distance from any wiring closet.

The charts for single-wiring-closet rings are based upon the cabling assumptions in Chapter 2 for single-wiring-closet rings. If these assumptions cannot be followed, the data in the table can be modified by applying the adjustments described later in this appendix. To use the charts, find the row that matches the number of 8228s you will need in the ring and the column that matches the number of racks that the ring will use in the wiring closet. The number at the intersection of the row and column is the longest allowable lobe length. For example, according to the charts in Figures A-1 and A-2, a 4 Mbps ring with 10 8228s in 3 racks has a longest allowable lobe length of 1066 ft (325 m).

In some cases, where the length of the longest lobe in a single-wiring-closet ring exceeds the length specified in the applicable chart, repeaters or converters may be used in the main ring path to alleviate the problem. To accomplish this, follow the rules for multiple-wiring-closet rings to determine placement of repeaters and converters.

Often, where long lobe lengths are required, replacing 8228s with 8230s is preferable. At 4 Mbps, 8230s support lobe lengths of up to 375 m (1180 ft); at 16 Mbps, 8230s support lobe lengths of up to 145 m (478 ft).

The following sections describe how to convert lengths of a given cable type to equivalent lengths of another type. The ratios used in these sections are for use in both 4 and 16 Mbps rings.

Adjustments for Undercarpet (Type 8) Cabling

IBM Cabling System type 8 cable for undercarpet installation has characteristics different from those of the type 1 or type 2 cable that it may replace. If all or part of your cabling is to be type 8 undercarpet cabling, count each length of type 8 cable as though it were twice its actual length. For example, if one of your lobes is 50 ft long and is made up entirely of type 8 cable, you should treat it as though it were 100 ft of cable.

Further, if a 50-ft cable run is one-half type 1 and one-half type 8, you should treat it as though it were 75 ft long (two times the length of type 8 cable $[2 \times 25 = 50]$ plus the length of type 1 cable $[25]$ equals 75).

Adjustments for Excess Patch Cable (Type 6) Length

If your installation requires that you use longer patch cables in some parts of your ring, you must consider these extra lengths when determining the size of your ring.

In *single-wiring-closet configurations*, add 17 ft (5 m) to the computed length of the longest lobe in your network each time you substitute a 30-ft (9-m) patch cable for an 8-ft (2.4-m) patch cable in the main ring path (that is, between 8228s in the main ring).

If you substitute a 30-ft patch cable for an 8-ft patch cable between an attaching device and a faceplate or between a distribution panel and an 8228 lobe receptacle, add 33 ft (10 m) to that lobe length.

In *multiple-wiring-closet configurations*, add 33 ft (10 m) to the adjusted ring length as calculated in Chapter 2 each time you substitute a 30-ft patch cable for an 8-ft patch cable in the main ring path (that is, between 8228s on the main ring).

Add 33 ft (10 m) to the computed lobe length each time you substitute a 30-ft patch cable for an 8-ft patch cable on a lobe between either the attaching device and the faceplate or between a distribution panel and an 8228 lobe receptacle.

Adjustments for Additional Patch Cables in the Ring

If your ring contains more patch cables than those already specified in Chapter 2, you should apply the following adjustments.

For *single-wiring-closet rings*, add 8 ft (2.4 m) to the computed lobe length for each additional 8-ft (2.4-meter) patch cable in the main ring path and 27 ft (7.5 m) for each additional 30-ft (9-meter) patch cable in the main ring path.

Add 17 ft (5 m) to the length of a lobe for each additional 8-ft patch cable between an attaching device and a faceplate or between a distribution panel and an 8228 lobe receptacle. If a 30-ft patch cable is added in these circumstances, add 50 ft (15 m) to the computed lobe length.

For *multiple-wiring-closet cases*, add 17 ft (5 m) for each additional 8-ft patch cable and 50 ft (15 m) for each additional 30-ft patch cable to the adjusted ring length for patch cables added to the main ring path.

For patch cables added to lobes between attaching devices and faceplates or between distribution panels and 8228 lobe receptacles, add 17 ft (5 m) for each additional 8-ft patch cable and 50 ft (15 m) for each additional 30-ft patch cable to the lobe length.

Adjustments for Replacing Type 1 or Type 2 Cable with Type 6 or Type 9

If you substitute type 6 cable for type 1 or type 2 cable, multiply the length of the type 6 cable by $\frac{4}{3}$ and use that figure as the cable length.

If you substitute type 9 cable for type 1 or type 2 cable, multiply the length of the type 9 cable by $\frac{3}{2}$ and use that figure as the cable length. For example, 90 ft of type 6 cable should be treated as though it were 120 ft of type 1 or type 2 cable. Ninety ft of type 9 cable should be treated as though it were 135 ft of type 1 or type 2 cable. Patch cables are made of type 6 cable.

Seventy-five-foot patch cables should be treated as though they were 100 ft of type 1 or type 2 cable. One-hundred-fifty-foot patch cables should be treated as though they were 200 ft of type 1 or type 2 cable.

Calculations for Substituting Type 6 Cable and Type 8 Cable

If you need to substitute type 6 cable for type 8 cable or vice versa, convert the known amount of cable to its type 1 equivalent, and then convert the new amount to the equivalent of the new type. For example, 100 ft of type 8 cable is the equivalent of 200 ft of type 1 (to convert type 8 to type 1, multiply by 2). Since type 1 equals 4/3 times the length of type 6 cable, 200 ft of type 1 is equivalent to 150 ft of type 6. Therefore, 100 ft of type 8 is the equivalent of 150 ft of type 6 cable.

Using Surge Suppressors with the IBM Token-Ring Network

Surge suppressors are permitted in 4 Mbps rings only. Before installing any network between buildings, you should consider that using optical fiber cabling rather than copper cabling protected by surge suppressors provides superior protection from lightning, avoids ground potential difference problems between buildings, and enhances network security.

Surge suppressors are not permitted in any ring segment bounded by 8220 Optical Fiber Converters.

If you must use copper cable with surge suppressors, you should follow the guidelines below.

If your ring will use wiring closet-to-wiring closet cables that are connected to surge suppressors *but without 8218 Copper Repeaters*, your network should observe certain guidelines in addition to those found in the multiple-wiring-closet section of Chapter 2:

- Surge suppressors cannot be used between attaching devices and 8228s.
- Rings using surge suppressors in the main ring path are limited to passing through two wiring closets.
- No more than 16 IBM 8228s may be used in a ring with surge suppressors.
- Add 60 m (200 ft) to your calculated adjusted ring length to account for signal loss caused by the surge suppressors between wiring closets.

If you are using surge suppressors and 8218s in the same ring segment, follow these guidelines:

- Surge suppressors cannot be used between attaching devices and 8228s.
- Ring segments between surge suppressors may have 8228s in no more than two wiring closets with no intermediate surge suppressors.
- Up to four surge suppressors may be in a ring segment where repeaters are immediately adjacent to surge suppressors at each end of the ring segment. If repeaters are not immediately adjacent, only two surge suppressors per segment are permitted.
- You may have no more than 16 8228s in a ring segment with surge suppressors.
- Add 30 m (100 ft) to the length of the cable nearest the surge suppressor in the segment.

If you are using surge suppressors between two 8230s, add 60 m (200 ft) to the length of the cable between the two 8230s.